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COST AND PRODUCTION OF POWER FOR TRACTION PURPOSES.

MR. J. S. RAWORTH'S paper on "The Generation of Electrical Energy for Tramways," which was published in our last issue, is well timed, coming, as it does, at a moment when many corporations possessing electric lighting plants are rather desirous to compel tramway companies to buy the power they require from the municipal works at high rates.

Before discussing the point which Mr. Raworth states he wishes to demonstrate, viz., that "a suitable and paying price for the supply of electric energy for tramway purposes, under reasonably favourable conditions, is *one penny* per unit;" we must say that the title of the paper, and the reputation of the author, led us to expect rather more than we have obtained. We scarcely needed a repetition of what Mr. Williams, Mr. Crompton, Captain Sankey, and Mr. Raworth himself have told us over and over again, nor does it, to us, seem necessary to now discuss the constant expansion engine, which no sane engineer would dream of using for traction work.

We had hoped to have obtained from Mr. Raworth's store of experience in steam engineering some new data as to the special points to be considered in the design of engines built for traction purposes, or results obtained from actual tests as to the cost of production and efficiency obtainable. Mr. Raworth when he talks about direct coupling does not go into it, not wishing to tell us "that Queen Anne is dead," but he seems to be telling us this interesting fact throughout his paper.

He apparently believes that he makes a bold statement when he says that "the total variation in speed may easily be covered by 2 per cent." This is ancient history at least so far as electric traction is concerned. There are several standard traction station engines which, when their *full* rated load is instantaneously thrown on or off, do not vary 1½ per cent. in speed, and whose angular velocity during one revolution does not vary one-half of 1 per cent.

In the beginning of the paper, Mr. Raworth mentions that one of the problems which engineers have had to solve is how to drive a dynamo economically at full and light load. It is a pity he offers no solution as to how to do this with the engine.

We are certainly indebted to Mr. Raworth for calling attention to the unquestionable fact that the cost of production of power for tramway purposes is, if anything, cheaper than for lighting, and to the exorbitant prices charged for power by lighting stations.

Mr. Raworth must refer to the *future* of electric traction in this country when he speaks of a *small* road consuming 1,000,000 units per annum. This figure could only apply to a 40 or 50-car road. The largest electric tramway in the Kingdom at present does not boast of half this service.

We consider Mr. Raworth's figure of 1d. per B.O.T. unit as the sale price as being, if anything, rather high for large

outputs. In such cases the cost of production would not be one-third of a penny, as has been proved by the experience of large numbers of American roads. Even on comparatively small English and Continental roads the cost of the unit is well below one penny.

One special feature of electric tramway engines is that they are so much more heavily designed than an engine of the same power for lighting work. The ratio of the length to the diameter of the bearings is rarely less than two to one, and all movable and fixed parts are designed for the strains they would have to bear if they were always working at 50 per cent. overload.

All specifications for railway engines require that they should give a certain power at their most economical cut-off, and be able to furnish 50 per cent. more power whenever required without slowing down or causing undue heating of the bearings. We are glad to note that Mr. Raworth speaks so highly of the automatic shaft governor. We believe this to be of the utmost importance. It must be noted that most of the disastrous fly-wheel accidents which have happened are traceable to ball governors. This is so much the case, that all well-informed builders of electric railway engines who employ ball governors put in two governors, one of which, if the speed increases beyond a certain limit, cuts off the steam entirely. This is entirely unnecessary with properly-designed fly-wheel governors.

As regards coal consumption, Mr. Raworth is quite right in stating that 2 lbs. of coal per I.H.P. is high in ordinary railway practice. With a properly-designed condensing plant, capable of supplying regularly one to two million units per annum, this is found to be as low as 1·67 lbs.

It would be well for those interested in electric lighting plants to bear in mind that in a combined light and traction station the production of energy for lighting must be secondary to the supply for traction purposes.

Tramways and Municipalities in the United States.

Matters in the States do not as yet appear to be anywhere near the condition we find them in on this side in respect to the municipalisation of tramways, but there is a decided tendency in that direction, which has been shown in various ways. Chicago, for instance, has begun to make it conditional upon granting further leases or rights of user of the public streets for electric tramways, that a percentage of the gross receipts shall be paid by the tramway company to the city. Moreover, instead of granting a lease in perpetuity, the term is fixed at 20 years—a period which we opine will be found rather too near the opposite extreme. Certainly in this country a lease of 21 years may be regarded as the minimum period during which a fair return upon the capital outlay can be obtained, even with all the advantages of electric traction: on the Continent the more usual term is 40 and even 50 years. The Chicago city authority receives from the tramway company in respect of new leases nothing for the first five years, 5 per cent. during the second, 7 per cent. during the third, and 10 per cent. during the last quinquennial period. Action of this kind—whatever one may think of tramway municipalisation and hindrances to the development of tramway companies at the hands of local authorities—has much more to commend it than the methods followed in other American cities (with very doubtful success) of obliging the electric tramway companies to reduce their fares to a point where no profit at all can be made. This is done by passing ordinances to the effect that fares shall be directly lowered, or indirectly reduced by the granting of universal transfers, so that a single fare payment carries a passenger from one end of the system to the other. This may not appeal to us very strongly at present, seeing that we have no great length of electric line at work, but as time goes on and lines increase, we shall probably see a little of the same tendency at least on the part of the public.

The Emission of Light.

Those who are interested in photometry, and, generally, in the state of our knowledge respecting the emission of light and its measurement, should study a paper by H. Kruss in the *Journal für Gasbeleuchtung*, 1896, Vol. 39, p. 425. The results are given of researches made by Lummer, Karlbaum and Wien, at the Reichsanstalt on a suitable standard or unit of light emission, and also of experiments by St. John on the emissive powers of substances. Experiments with Violle's platinum unit and Siemens's modification of it have shown that methods depending upon the melting point of platinum are not satisfactory. Lummer and Kurlbaum adopt as their unit the amount of light emitted from 1 sq. cm. of glowing platinum foil at a fixed temperature. The foil used is of pure platinum, 25 mm. broad, 60 mm. long, and 0·015 mm. thick, and is heated by passing through it a current from a secondary battery. In front of it is placed a suitable diaphragm with an aperture of 1 sq. cm. The temperature is fixed by a peculiar and interesting absorption method. The absorption vessel consists of a cylindrical glass ring closed by two quartz plates, 1 mm. thick, and containing a layer of water 2 cm. thick. The proportion of the total radiation transmitted through such a vessel depends upon the temperature of the radiating surface. The normal temperature is fixed as being such that the proportion of the total radiation transmitted shall be one-tenth. The radiation is measured, and the proportion determined by means of a bolometer. As far as this element is concerned, the unit can be fixed to an accuracy of 0·3 per cent., or, taking all sources of error into account, to an accuracy of 1 per cent. St. John has compared the brightness of a hot platinum surface with that of a part of the same platinum at the same temperature but coated with a metallic oxide. The platinum foil was enclosed in a furnace at a temperature of 1,100°—1,200° C., and the observations were made through a hole in the wall of the furnace by a spectro-photometer. Taking the brightness of the plain platinum foil for a given wave length ($\lambda = 0{\cdot}540$) as unity, that of the other surfaces was only found to vary from 0·987 in the case of didymium oxide to 1·017 in the case of lanthanum oxide. Within such a closed hot space the brightness does not measure the emissive power, for the radiation is the sum of the energy emitted and reflected from the surface; and the results are in entire accordance with Kirchoff's law, according to which the sum of these in any given direction should be constant for all surfaces and equal to that from a perfectly black surface. Unfortunately, St. John has not examined the behaviour of thorium oxide, which is used in the Auer burner. But the fact that the rare earths investigated behave in accordance with Kirchoff's law is fatal to the suggestion which has often been made that they have a specific luminosity or power of emitting, in the form of light, a part of the energy absorbed in the formation. The observed gradual decrease of efficiency of the Auer burner must be ascribed simply to a gradual contraction of the mantle, or of its active surface, and not to any supposed diminution of its specific luminosity. The measurement of brightness above described can be converted into a method of measuring emissive power by pushing a hot (but not glowing) porcelain tube through the walls of the furnace close up to the platinum plate, and observing through this tube; we thus cut off reflected light and only observe that directly emitted. Taking the emissive power of platinum as unity, that of lanthanum oxide is found to be 2·15, and that of zirconium oxide as high as 3·15.

UNINSULATED PIPE FOR INTERIOR WIRING.

By V. ZINGLER, A.I.E.E.

(*Continued from page* 624.)

Accessibility.—This is meant to include draw-through and inspection. Now there was an article in the ELECTRICAL REVIEW of April 9th, p. 484, extracted from the *Electrical World*, which hit the right nail on the head; in this the author advocates high grade wires, less braid, and a smooth lining to the pipe. (He says *insulating* lining also; but if this is not a slip on his part, I cannot agree with him. If he has the high grade wire, he does not want the insulating lining). It is for this reason that 50 per cent. extra was allowed for lining the pipes with a smooth material, under the heading of cost of material. If small pipes of this size could be porcelain enamelled, the desired result would be obtained; but I do not believe this can be done yet. The whole reason of the failure of a great many pipe installations has been that the pipes have had ridges inside, or fins or burrs, which have torn the wires. And it has been a mistake to think, as many have thought, that a wire with extra braiding will resist these obstructions. On the contrary, the braiding frays and tears, and when the pipes ultimately become moist, the braiding absorbs the moisture and swells out. If, then, any repair becomes necessary, it is exceedingly difficult to withdraw the wires from the pipe. What we want, then, for a perfect draw-through is a pipe with a smooth interior, and although the insulated tubing fulfils this requirement, it should be much cheaper before it can be considered commercially with gas barrel. The ideal system, in my opinion, is to have smoothly lined pipes with highly insulated wires, the wires being of best compound rubber, merely taped and compounded. The rest of the question of draw-through rests with the engineer who plans the installation, and this applies to any system. It is his business to see that there are as many boxes and as few bends and as straight runs as possible.

Durability.—If we consider the question from the point of view of depreciation, the whole installation rests on its insulation, *i.e.*, on the quality of wire drawn in. There are, of course, other dangers, such as fire and water. Water has been dealt with already, but as regards fire, I am afraid the insulated tubing would not have many of its properties left if it got red hot. The wires would most likely have to come out in any case, but it would assuredly be easiest to re-wire a tube which had not had a bituminous compound in it before the fire. To sum up, what we require is an installation which will not break down; and, after all is said and done, the insulation is at the bottom of everything. Mr. Ward Leonard writes to the *Electrical World*, "Exceedingly high insulation is of less importance than insulation which will remain unaltered in the course of years."

This completes the several points we had to consider. There are, of course, many minor ones, which present themselves in actual practice, some common to both systems, others peculiar to either system; but all come more or less under the foregoing headings and are mainly discovered only by experience.

This may be said to form the case for the uninsulated pipe system, and I think I have shown that at any rate for equal insulation it is cheaper in first cost and more durable than the insulated system. If people are, however, willing to pay for insulated tubing and high grade wire inside, there is no reason why they should not do so; the question is only what is best for our money down with interest and depreciation. It is at any rate to be hoped that architects and consulting engineers will not fail to keep up with the times, as there are very few of the former who have taken advantage of the fact that the pipes for electric light wires can be run as the building is being erected. In fact it is sad to relate that the architect more often than not makes no provision at all for the electric light. When he does we may be able to agree with Mr. Ward Leonard, who says "the best work done to-day is laid out in the office and the tubing is cut to the exact lengths required, and the workman merely couples together the proper lengths." This opens up a vista of the future; building a house in England and sending the plans to America, where the whole pipe work for electric light wires will be laid out, bent, cut, erected, taken down, marked for re-erection, and sent over here. And as long as consulting engineers specify casing sunk in the plaster for 200-volt supplies, as is still being done, we may despair of getting installation work for eternity.

The uninsulated pipe system has been in use for many years on ships, where it is, however, mostly run on the surface, or at least in accessible positions. There has not, I imagine, been any attempt to standardise it in any way, although a few firms have used it for house wiring; but they have all done it their own way and used their own patterns of boxes, &c. It would be interesting to know what the costs have worked out at, and what the subsequent experience has been as regards insulation and depreciation. Perhaps some contractors will give their experience of both systems, and then a useful comparison of different methods could be made. As far as the gas barrel system is concerned, I believe that the best work, including cutting away, wiring and making good, can be done for about 30s. a point. But in any case it would take any contractor time to get used to a

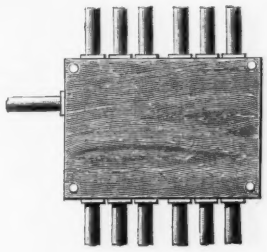


FIG. 1.

new system, and no sort of reliable cost could be got out until he had undertaken several such installations. It is so possible to get work scamped and thus give an erroneous idea of the cost; it is also possible to obtain the same result by mismanagement, when the cost comes out too high. Both of these faults occur very frequently, although the former is the usual one to which attention is drawn. Both are, however, an immoral form of trading, for in the first case the customer is led to believe that he gets more than he pays for, and in the latter case he pays for more than he gets. In either case the same amount of money eventually comes out of his pocket—by the first in after charges, and by the second in overcharges. However, this is a digression, though perhaps a pertinent one.

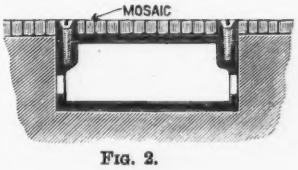


FIG. 2.

We will now consider some of the most important points to be observed in laying out and installing an uninsulated pipe system, always bearing in mind that each installation must be considered on its merits and separately.

Runs.—All runs should be as straight as possible. Those from main switch to distributing board, and thence to the fuse boards, should be in easily accessible places, and plenty large enough. An air or lift shaft is the best places for vertical runs for mains, and at each floor there should be a large distribution box in the wall, with the outlet for that floor. If possible, each floor, *i.e.*, each pair of mains, should have its own pipe, as many wires in one pipe are apt to twist. Such a box as fig. 1 is suitable; in fact, an ordinary C.I. box, with clearing holes for pipes, and check nuts inside and outside. No effort should be lost to attain straight runs everywhere, as on this depends the whole question of future renewals or extensions.

Bends.—These should be avoided altogether if possible, and a box put wherever a bend should be. At any rate, not more than one right-angled bend should occur between any two boxes, and in the same plane.

Traps.—No box should be permanently covered over, but a trap should be made in the floor above. The pipes should be laid in such a way that the traps come in easily accessible places and also in symmetry with the floor pattern. In the case of concrete or stone floors the top of the box may be chequered and flush with the floor. In mosaic the lid of the box may be a shallow dish, afterwards filled in with mosaic, and with lugs for screw holes, as fig. 2. Or in the case of parquet flooring, the blocks immediately above the box should be tongued and grooved, glued together and then screwed into a fixing, so that they will all come up together.

(*To be continued.*)

THE ROTARY STEAM ENGINE.

The recent experience of an acquaintance of ours with a rotary engine induced us to read an article in the *Scientific American* from the pen of Prof. Thurston upon the rotary engine. He describes the rotary engine as one of the seductive class of mechanisms that have tantalised the engineer and inventor for generations. Watt's patent of 1769 for a rotary engine contains the following for its fifth claim :—

"Fifthly.—Where motions round an axis are required, I make the steam vessels in form of hollow rings or circular channels, with proper inlets and outlets for the steam, mounted on horizontal axles, like the wheels of a water mill. Within are placed a number of valves that suffer any body to go round the channel in one direction only. In these steam vessels are placed weights, so fitted to them as to fill up part or portion of their channels, and yet capable of moving freely in them by the means hereinafter mentioned or specified. When the steam is admitted in these engines between these weights and the valves, it acts equal on both, and so as to raise the weight on one side of the wheel, and, by the reaction of the valves successively, to give a circular motion to the wheel, the valves opening in the direction in which the weights are pressed, but not in the contrary."

Thus, even, Watt himself had possibly some idea that a better system could be evolved than that of the crank. Nothing yet constructed on Watt's rotary patent has ever been one iota of good. All rotary engines of which we have ever seen anything on paper or in actual form resemble this early patent of Jas. Watt. We might possibly except that most ingenious construction the Tower spherical engine, which, however, no engineer of experience could see without realising the enormous surface friction in proportion to the piston volume generated. In all these rotary engines a piston attached to a central spindle revolved with this in an annular chamber: at a certain point in the circle the chamber could be closed. Between the closing plate and the revolving piston was admitted the steam and it was exhausted in front of the piston. The closing plate was placed between the steam and the exhaust valves. Obviously this closer had to be movable, for it was necessary that the piston should pass it every revolution, and it was equally necessary that the plate should close instantly behind the piston so as to form the abutment for the next charge of steam. Unless it did so close there would be the equivalent of very late admission. A large part of the stroke would be useless as regards work, yet it would be filled with steam every stroke just as it would if the closer plate had shut promptly. But in a rapidly revolving engine this plate could not close so quickly as to avoid waste spaces. The rotary engine problem resolved itself simply into one of valve movement. Pistons were made with variously sloped faces to raise a swinging flap which should swing to after the piston had passed. Thin plates were variously geared up to shoot rapidly to and fro either radially or in a direction parallel with the axis. They were moved by cams, shut by springs, opened and closed entirely by steam. The latest design we have seen used a common or garden type of cylinder and piston to actuate its shuttle valve. The present writer's own idea of a rotary engine valve was, for it is some years since the rotary idea left him, to use a thin disc with several ports cut through it of such length that when rapidly revolved a hole should come to position as the piston passed, and during as great a part of the revolution as possible the disc would be blank. All the ideas we have seen or thought of have been absolutely useless or impracticable, and the ordinary rotary engine is in fact one of those things that won't do, and the expert engineer who is now approached with a view to advise on a rotary engine knows beforehand that he has little else to do but paraphrase his last report.

We except, of course, from our category of rotary engines those having no pistons, such as Hero's reaction wheel of 120 B.C., and Branca's jet wheel of 1629 A.D. We referred to piston engines, all of which have proved failures. Branca's engine was a failure, not because it was wrong in principle, but because sufficient steam pressure was not available. To-day the de Laval turbine is simply a recrudescence of the Branca wheel with a detail or two improved as the sole result of 250 years experience; details, moreover, such as the jet piece and the wheel vanes, that would probably have been improved at the time just as well as now had there been a sufficient pressure to give success.

The ordinary rotary engine has shown itself also incapable of nice governing, and of poor economy to boot, nor has it shown great power per unit of weight, nor a capacity for variable cut-off. It would fail quickly from leakage even if right otherwise, and it is, in fact, a rank failure. It is curious that with the early engine of Hero and Branca, no inventor should have recurred to the impulse type, and presented to us earlier the curious spectacle, as Prof. Thurston puts it, of the world going back to the time of Hero, over 2,000 years, to find the true type of engine. In the use of water the earlier wheels were probably float wheels actuated by water in motion. These gave way to wheels worked by water which was not in motion until it began to move as it entered the wheel. It then acted by gravity. Steam, which began to work as a moving fluid in the jet wheel, was compelled to work by pressure till recently. Now both steam and water have reverted in the Pelton wheel and De Laval wheel to their earliest modes of action. Scientific acquaintance with the true action of the steam in our engines shows us that in the jet turbine the worst form of waste, or rather cause of waste, is done away with. We refer, of course, to the cylinder condensation which cannot arise except in a reciprocating engine, and is quite absent in the jet wheel. The bar to success in these jet wheels and in steam turbines is the high speed necessary to secure best efficiency. Some De Laval wheels run as quickly as 30,000 revolutions per minute, and require to be hung so flexibly as to find their own centre of rotation. But given mechanical constructive ability there appears no reason why the steam turbine should not secure a very fair efficiency indeed.

AN INEXPENSIVE, ADJUSTABLE CONDENSER FOR HIGH POTENTIALS.*

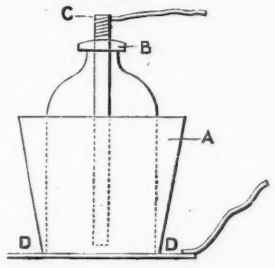
By LUCIEN I. BLAKE.

One of the main practical difficulties of high-potential apparatus has been the condenser. The historic Leyden jar, or some modification of it, employing glass as a dielectric and tinfoil coatings, has been the chief, though unsatisfactory and easily destructible, condenser of the laboratory. Various solid dielectrics have been used in place of glass, but all break down readily under high pressures, and have not proven convenient to construct in adjustable capacities. All have been expensive. The recent attention given to electrostatic work, especially with X ray apparatus employing Tesla coils, emphasies the need of a cheap adjustable and non-breakable condenser. Such a condenser has been devised and constantly employed for nearly a year now in the physical laboratory of the University of Kansas. Its expense of construction is trivial; it can be built in any capacity, and delicately tuned

* *Electrical World*, November 7th, 1896.

to any circuit, and is readily adjustable. It has proven itself so vastly superior to any other type of condenser known to the writer that a description of it may prove useful to other experimenters.

The accompanying figure will show at a glance the form which the writer has developed as the most convenient portable one for ordinary work. A is a tin jar 7 inches high, 8 inches diameter at top, and 5 inches diameter at bottom ; B is a two-quart glass bottle of ordinary glass ; C is an electric light carbon ; D is a sheet of tin. The bottle is filled to any height with water, slightly acidulated or containing common salt, and a similar solution is poured into the tin jar to the same height. The jar is then placed upon a sheet of tin, which is connected with one electrode, while the carbon rod



is connected to the other, of any apparatus used. A number of these jars may be connected upon the same tin and any capacity obtained. Liquid may be poured into each jar until the proper tuning is obtained, and this is determined readily by the intensity of small sparks which appear on the sides of the bottles at the surface of the water.

The original idea of an electrolyte in place of tinfoil coating is due to Mr. F. C. Penfield, a student in the laboratory. If the outer tin jars are built in a "nest," the apparatus is easily packed for transporation. This form of condenser has proven applicable to every type of laboratory work. Should a bottle be pierced by a spark, it is quickly replaced by another bottle. Boiled linseed oil rubbed on the exposed outer surface of the bottles will prevent sparking over. Such condensers have been standing over 500,000 volts pressure continually in this laboratory, and are used almost exclusively now in all condenser work.

DISCUSSION ON MR. HOWELL'S PAPER ON THE SPECIFIC RESISTANCE OF CARBON FILAMENTS, AND ON THE "EDISON EFFECT."

Our issue for April 31st contains a report of Mr. Howell's paper on the above subjects. We now proceed to notice some of the more interesting points that were brought forward in the discussion which followed the paper.

Mr. Howell opened by giving a few further particulars regarding the graphite conductor he had experimented with. He had ascertained that the specific resistance of the carbon was 450 ohms. The lowest specific resistance for amorphous carbon that he had come across was 2,200 ohms, and that of carbon deposited in the treating process was 350 ohms. The specific gravity of the latter kind of carbon is also practically the same as graphite. The graphite filament had been made by very powerfully compressing graphite in a die, the thickness being "one circular mil area."

Dr. A. E. Kennelly, after some complimentary observations, drew attention to the well-known pulsatory effects that a Geissler tube will give when worked by a direct current, which pulsatory effects will give rise to alternating currents in a separate circuit. Mr. Howell had now shown how an alternating current, passed through an incandescent lamp, would produce a unidirectional current in a branch circuit through a third wire in a lamp. "Consequently, it is interesting to observe that a vacuum tube, in the broadest sense of the term, is capable of supplying not only alternating currents from continuous currents, but also continuous currents from alternating currents." He thought that some of the experiments described seemed to differ from those obtained by Dr. Fleming, who had come to the conclusion that the discharge could only travel in a straight line, whereas in some of Mr. Howell's experiments it seemed to go round a corner.

Mr. Colby, after referring to an experiment connected with the Edison effect in which a telephone was used to detect currents traversing vacuous space (the experiment has been fully described in an article on a similar discussion to the present one to be found in our issue for May 18th, 1894), proceeded to confirm Mr. Howell's experience with bromine lamps as regards absence of blue haze in them. He stated, further, that there was a like absence with a residual atmosphere of chloroform vapour. On the other hand, he had found the presence of certain other vapours to greatly increase the blue effect, and notably recalled an experiment in which some cyanide of mercury had been placed in a tube connected with a lamp which had been exhausted. Upon heating the tube and forcing the vapour of mercuric cyanide or its components into the bulb and running the lamp brightly, the blue discharge suddenly appeared, and spread out in concentric rings from the positive wire and nearly reached to the negative. After a few minutes the lamp short circuited. A similar experience occurred with some of the first tamadine filaments that were made, the discharge being of a violet blue colour, and short circuits being of frequent occurrence. These results Mr. Colby attributed to imperfect "baking," but it is a question whether the real cause was not rather due to having imperfectly washed out foreign matter in the preparation of the tamadine. Mr. Colby also stated that he had made a lamp with glass tubes fused round the platinum wires and surrounding the stubs and lower portion of the filament. With this lamp he had had the same experience as Mr. Howell, viz., that it had been necessary to raise the temperature of the filament much higher than usual before the blue colour appeared, and that when it did there was a rush of current sufficient to fuse the glass. He asked whether Mr. Howell had ever used a spectroscope in his experiments. He had done so himself on one occasion in 1883 to observe a lamp giving a particularly blue effect, and had noticed some very bright lines to the right of the D line, but unfortunately before their position could be properly noted, the lamp short-circuited. The sodium line was clearly seen, but the most striking was a bright green line, which Mr. Weston had thought was due to mercury. He thought "it would be very interesting, if Mr. Howell had the facilities, to study the blue discharge by means of the spectroscope. Possibly we can thus get information as to what matter is present giving rise to the discharge."

Some discussion took place as to the nature and method of preparation of tamadine, during which the information was elicited that the material had been so named by the secretary of Mr. Weston's company from a Greek word signifying "without structure."

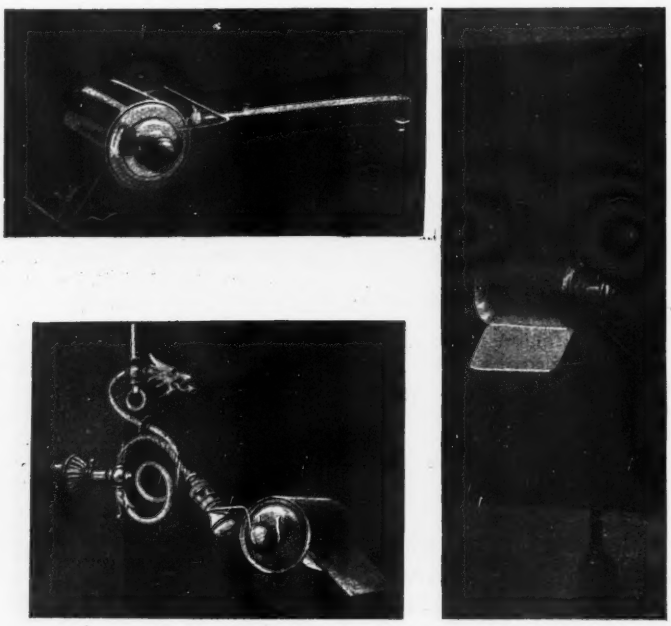
In replying, Mr. Howell said that his conclusions were not in conflict with those of Prof. Fleming. "Prof. Fleming's work was all done with lamps which were highly exhausted. All the highly exhausted lamps with which I experimented behaved exactly as Prof. Fleming's did. There was every indication that the molecules passed in straight lines only. . . . . The power to pass in other than straight lines exists only, so far as my experience shows, when the vacuum is in a condition to show a blue glow. In that case I believe there is a large number of molecular collisions constantly occurring in the vacuous space, and perhaps the charged molecules do not go from the negative to the positive around corners, but go to other molecules to which they give up their charge. Probably the motion is in a number of straight lines instead of one. But in all cases in which the lamp had a high vacuum, as it was in all the lamps Prof. Fleming used, I found no ability to pass in other than in straight lines."

Mr. Colby had asked the question whether he could say to what the luminosity of the discharge was due. He could not answer this fully, but he felt satisfied that it was not caused by molecules of carbon but by others. A well

exhausted lamp, after everything had been removed except carbon molecules, never showed a blue glow. Water vapour causes a very marked blue effect.

Mr. Howell's concluding remarks are worth giving in full:—

"The action of these molecules emanating effectively from the negative leg only, is very curious, and I hoped that the suggestion which I made at the very end of this paper would be taken up and discussed by somebody who knew more about it than I did; that is, that the action of these molecules in carrying electricity in one direction only may be an indication of the nature of the action between molecules in solid conductors, carrying conductors, rather than an illustration of the action of statically charged molecules. I think there is evidence that the action of these molecules has very little to do with their static charge. We know that in order to produce effects by a static charge in the ordinary vacuum you have got to use very high potentials and quite a large amount of actual energy. Whereas in these cases, a lamp which requires a very low potential difference will give a very strong molecular effect, and its passage in one way only is rather hard to explain. In fact, Prof. Fleming does not explain it. He says it is so because it is so, practically, and I am sure I cannot explain it. But it is a fact that the current is carried in one direction through the vacuum just as it would be if it were a conductor with all its resistance at the positive contact. If this were so, an inserted wire would show the same effects as those we observe in actual lamps. We have measured currents as high as 25 amperes passing through a space in which there is no continuous matter—that is, matter in the continuous condition we think of when we speak of a solid. When that current is passing, there is a vacuum there which is so high that it would scarcely depress a barometric column. In fact, I tried to measure whether there was a depression of a mercury column, and if there is any it is very slight indeed. Under proper conditions, a vacuum which will not appreciably depress a mercury column will carry a current and appear to have practically no resistance except at the positive contact. The vacuum will sometimes change from an almost perfect insulator to an almost perfect conductor suddenly, and without any gradations at all. It will be a sudden change due only to a suddenly acquired ability of the molecules to carry the current across space in one direction only. The indication of the unidirectional current from the alternating current is very interesting. It was a natural result, and it is one which I predicted before I tried it. I made an indicator for an alternating circuit in that way by using a lamp with a third wire, which had a high degree of exhaustion on an alternating circuit, the alternating circuit giving the carbon its temperature, and the variations in the current affected an ordinary direct current galvanometer connected between the inserted wire and one electrode, and it seemed very strange to see an unidirectional current taken out of an alternating current in this way."



Prof. W. M. Stine communicated some remarks on the paper, from which we give the following excerpt:—

"Perhaps the most singular phenomenon in this connection is the unilateral nature of electrical discharge from an incandescent source. The carbon vapour itself conducts equally well in any direction, but the discharge takes place only from the negative side of the filament. This, again, is another proof that the 'Edison effect' is not a static one, since the entire filament would be covered with a static discharge of the same sign. Guthrie long since showed that an incandescent conductor would discharge negative but not positive electricity. The action of the Crookes tube with cold electrodes is, in the main, of a similar nature. These facts indicate, as Lord Kelvin pointed out some years since, that there is a radical difference in character between positive and negative charges. It is probable we shall yet find in such facts as these the explanation of the nature of electrical conduction."

ESPERSEN ADJUSTABLE SHADE LAMP.

Among the specialties that are attracting attention at this time is the Espersen adjustable shade lamp, which is illustrated in the accompanying cuts. It is claimed, says the *Western Electrician*, that these lamps afford complete protection to the eyes, permitting the light to be turned in any direction, and that it also increases the candle power one-half. This device can be used in any place or position where a good, bright light is needed. By simply turning the shade to a different angle, the light may be made dim or bright, and by revolving the shade toward the ceiling, a soft light may be obtained. In the sick room or hospital it can be used with good effect. It is claimed that if placed within two feet of a bed or a couch the light will not disturb a sleeping person, but will afford sufficient illumination on the opposite side to allow one to read the finest print. Fig. 1 shows the simplest form of the device with sliding standard. It can be adjusted to different heights like a student lamp. Jewellers, watchmakers, opticians, and others who use the light close to their work, find the lamp well adapted to their requirements. Another form is illustrated in fig. 2, in which there is a desk attachment for roll-top desks or upright pianos. An attachment for fastening into electric light sockets, for chandelier, wall bracket or where the fixture is already installed is shown in fig. 3. It can be readily adjusted and will allow the light to be thrown in any particular place, or the room may be darkened by turning the light at an angle. The application illustrated in fig. 4 is made for those who desire to read in bed or a reclining position. It is made adjustable to hang over the head of the bed, and can be removed without trouble. These lamps have attracted attention abroad as well as in this country and the Pacific Electric Company of La Crosse, Wis., which manufactures these devices, claims to have received many orders from England and the continent.

AUTOMATIC ARC LAMP SWITCH.

The switch which we illustrate below is made by Messrs. New & Mayne, Limited, and is designed for automatically switching off arc lamps by a clock control. It is specially suitable for large business premises where some of the lights are not required after a fixed time, and it is being used successfully for extinguishing what may be called semi-public arc lights at midnight, or later, after the staff have left.

The apparatus is very simple, as will be seen from fig. 1, and the diagram of connections, fig. 2.; these represent a switch used for extinguishing eight arc lamps arranged four on screws on a 200-volt circuit. To turn the current on to the lamps, the switch-bar is pushed home, compressing a strong volute spring, and is prevented from springing back by a small wheel and trigger. This wheel is connected to the core of a solenoid through a link, and when the coil is energised the link is drawn up, releasing the switch arm, which comes off with a very rapid break, the sparking being taken on two short pieces of arc lamp carbon, which may be quickly replaced. The switch is fitted with the usual loose handle. The clock, which may be of the inexpensive American kind, completes the circuit of the solenoid, and is set in much the same way as an ordinary alarum clock. It will be noticed from the diagram of connections that when the main circuit is broken the clock circuit is also broken, so that there is never any sparking at the clock contact. The slight additional contact at, A, enables the switch to be used for extinguishing arcs, and at the same time turning on a large incandescent to run on, until the men arrive in the morning.

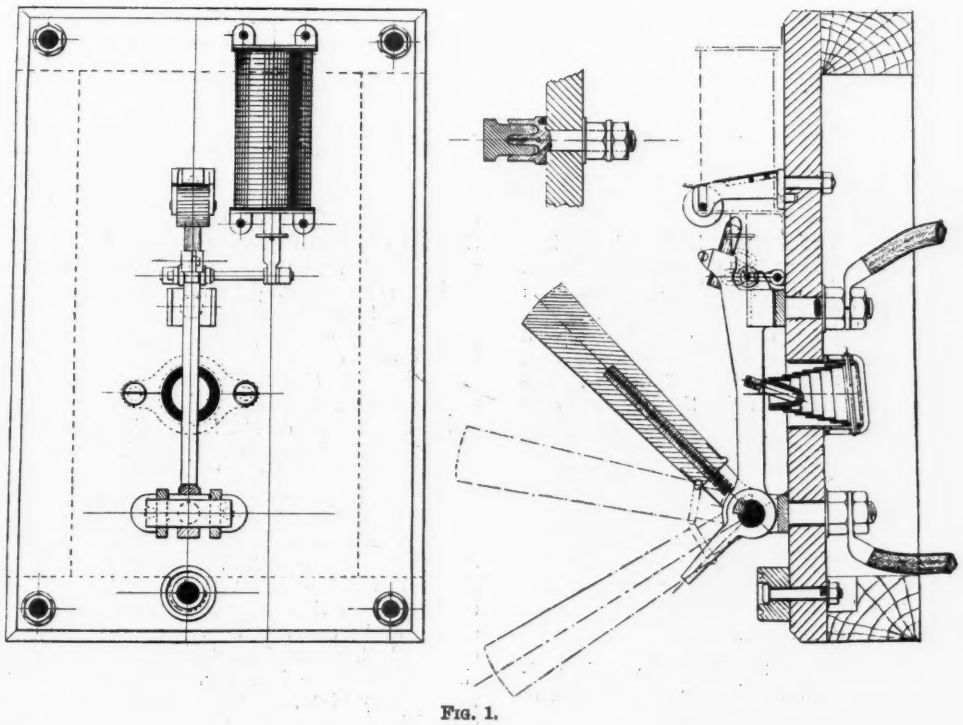


Fig. 1.

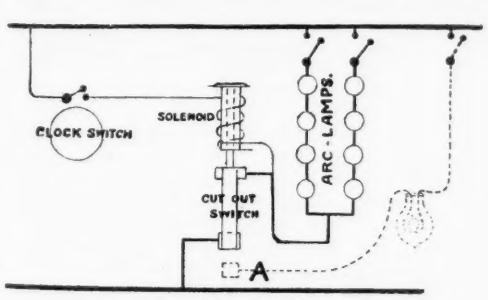


Fig. 2.

ELECTRICAL TREVELYAN ROCKERS.

By ROLLO APPLEYARD.

The literature* of the Trevelyan rocker is scattered among the British and foreign scientific journals of the past 60 years. Seebeck was the first to give a satisfactory explanation of the oscillatory motions; and Tyndall, working independently, very soon arrived at similar conclusions.

A short series of articles by Mr. A. M. Tanner in the Electrical Review of 1890 is perhaps the best *résumé* of the electrical phenomena.

So much good work has been done in this direction by others, that in bringing together the following experiments, I am doubtful how far to claim originality for them. Two, at least (Experiments 3 and 4), are discoveries rediscovered.

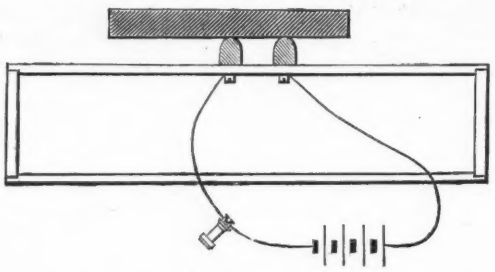
Experiment 1.—A simple microphone is formed of three carbon rods of square section. Two of the rods are fixed parallel to one another, and the third is laid across them. This microphone is mounted on a resonating box. When a current of about an ampere is sent through the system, the loose rod is set into rapid vibration. A "buzzing" sound is generally produced; it is best magnified by including a telephone in the circuit.

Experiment 2.—A tuning-fork is mounted on the same

* Reference should be made to the following papers:—
A. Seebeck. *Pogg. Ann.*, Vol. li., p. 1., 1840.
Tyndall. *Phil. Mag.*, Vol. xvii., p. 417, 1859.
G. Gore. *Phil. Mag.*, Vol. xv., p. 519.
J. D. Forbes. *Phil. Mag.*, Vol. xvii., p. 358, 1859.
A. M. Tanner. Electrical Review, Vol. xxvii., pp. 221, 279, 1890.
R. Appleyard. Electrical Review, Vol. xxvi., p. 57, 1890.
R. Appleyard. Electrical Review, Vol. xxvi., p. 656, 1890.

resonating box with a simple microphone, and a horse-shoe electro-magnet is arranged so that the prongs of the fork are free to vibrate between the projecting poles. The electro-magnet is connected in series with the microphone. The fork "drives" with a current of about 1 ampere. It is to be noticed that in this method of driving a tuning-fork the prongs are not encumbered with contact pieces. The microphone makes and breaks the circuit synchronously and automatically.

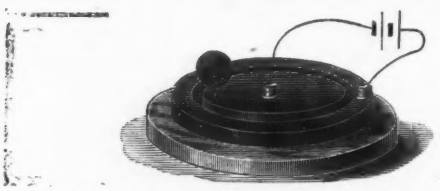
Experiment 3.—A spherical carbon ball is free to run in a circular channel between two concentric carbon rings. When a current of 2 or 3 amperes flows from ring to ring



Experiment 1.

across the ball, the ball rolls backwards and forwards, and sometimes progresses by complete turns. The motion is always erratic.

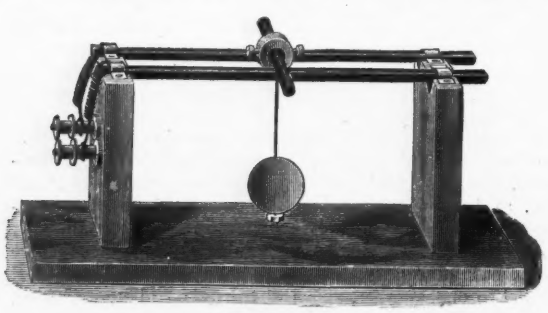
Experiment 4.—A large microphone is formed of three carbon rods of circular section, such as are used in arc lamps. Two of them are fixed horizontally, parallel to one another; the third, which may be shorter than the others, is laid across them at right angles. When a current of 2 or 3 amperes is sent through the three rods in any way whatever, the loose rod rolls or oscillates upon the fixed ones. The motion is generally capricious. This effect was observed



Experiment 2.

about 40 years ago by Fearn of Birmingham, who, by accident, placed a loose cylindrical metal rod across the bars of an electro-gilding trough.

Experiment 5.—The erratic movements of the loose carbon rod of Experiment 4 are checked and made more synchro-



Experiment 5.

nous by adding a bias below the axis of rotation. This is easily done by clamping upon it a metal ring; the ring may carry a pointer. If the pointer is sufficiently light, the loose rod will now oscillate through an angle which increases at each swing, and finally it will make a complete revolution.

Experiment 6.—A small pendulum with a stiff rod is attached rigidly to the clamped ring of Experiment 5, replacing the pointer. This brings the centre of mass of the loose rod still further below its axis of rotation. A current of about 2 amperes maintains the pendulum in continuous periodic motion.

REVIEWS.

The Application of Electricity to Railway Working. By W. E. Langdon. London: E. & F. N. Spon, Limited, 125, Strand.

There is probably no man living who is so competent to deal with the subject of the application of electricity to railway working as Mr. Langdon. His first publication, written just 20 years ago, was unique of its kind, in fact was the only book dealing with the subject, and now the new issue finds itself in the same position.

Although bearing the same title the present volume is practically a new work, and is a great advance on the old, excellent as the latter was.

Whereas the old work dealt exclusively with apparatus, in the new we have a considerable portion dealing with the important subject of line construction, in which the writer has had large experience. We regret to note the absence of the historical matter which occupied 14 or 15 pages in the old issue. Such matter, although perhaps of no great practical value, is still highly interesting, and might well have remained.

The progress which telegraphy has made within the last 20 years is astonishing, and although perhaps as regards railway telegraphy this progress is more noticeable in the direction of increased mileage of wire and number of instruments, than in actual improvement or changes in form of apparatus, still it can by no means be said that the changes which have been made in the latter direction are small or unimportant. Mr. Langdon states that within the last 20 years the mileage of wire solely devoted to the requirements of the railways of Great Britain has increased by 40,000 miles, and the number of instruments has been increased by no less than 80,000, resulting in a total of 100,000 miles of wire and 140,000 instruments. The railways of the United Kingdom are now worked entirely under the block system.

The first portion of Mr. Langdon's book deals with line construction, and stress is laid upon the extreme desirability of employing the best materials for the purpose, this being cheaper in the end in every way. The use of iron arms (tubular) has been largely adopted on the Midland Railway, and leave nothing to be desired as regards appearance and durability. As regards insulators, Mr. Langdon has a preference for the corrugated form, basing his preference on the supposition that the corrugations increase the length of surface to be traversed by the current. We have some doubts whether there is really anything in this supposition, the actual increase in length effected by the corrugations must be very slight, not more than 10 per cent. we should say. The statement that the finely rounded edges of the corrugations render the accumulation of dirt practically impossible, is also open to question we think. Has actual experience in the shape of numerous tests made on lines insulated with the corrugated and lines insulated with the plain insulators proved the superiority of the corrugated form? The Langdon terminal insulator seems to be a well designed arrangement of its kind, though mechanically the arrangement of an insulator at the end of an arm with the pull of the wire acting so as to drag the insulator over and to pull the arm out of position is a defective one, as anyone who has inspected a terminal pole can see. In this respect the Bright shackle, although very defective as an insulator, was mechanically a very perfect arrangement. The Fletcher terminal which is described, is also distinctly a good mechanical arrangement. As some doubt has been expressed as to the relative mechanical merit of iron and copper wires, it is interesting to note that in Mr. Langdon's experience, copper wires stand as well, if not better, than those of iron. Coming next to instruments we notice that although Mr. Langdon mentions the phonopore, it does not appear that the apparatus has proved particularly successful. Batteries are dismissed very briefly, though more space might, with, we think, advantage have been given to this subject. The use of dry cells is not recommended, as their condition cannot be ascertained by external inspection as is the case with the Leclanché. As will be seen from the summary given on page 85 of the book, various block systems are in use, Tyer's being apparently the one most employed. Interlocking between the electric and outdoor signals is still largely unadopted, though growing in

favour. Automatic block signalling, Mr. Langdon points out, has been a very favourite subject of invention, but principally by those whose acquaintance with the working conditions on railways has been of the slightest possible nature. This kind of signalling, it is stated, has made no progress in England, and for the reason that the conditions of traffic in this country render the employment of signal boxes imperative, and with the existence of signal boxes the value of an automatic system disappears. With the exception of a brief description of one or two American systems, no mention is made of foreign methods of block signalling, such for example as are employed on French and German railways. We also notice that although Walker's apparatus is stated to be still in use on the South Eastern Railway no description whatever is given of it. A very interesting section is that dealing with "Electric Light and Power," and the chapter on "Train Lighting" is also of great interest and value, although it rather indicates that a good deal remains to be done in this direction. Electrical intercommunication in trains in motion Mr. Langdon plainly states has "made no progress," and the subject is dismissed in a page and a half.

The concluding portion of the book deals with administration, and specification and order forms are given as an appendix, and it is, as we indicated at first, the only one of the kind in existence. Well got up and illustrated, and written by an engineer of great experience, it is a standard work, and will long remain so.

Kalender für Elektrotechniker von F. Uppenborn. München und Leipzig: R. Oldenburg, 1897.

Uppenborn, as is well known, has adopted the admirable plan of publishing a new edition of his valuable pocket book for electrotechnists every year, and is enabled thereby to keep it well up to date. This is the 14th edition and it is published in two parts. The chief alterations made in this edition consist in the additional space given to the subjects of alternating currents, central stations, transmission of power, and electric railways. Room has been made for these additions by the removal of methods of measurement, which are better adapted for the laboratory than the workshop, and also by leaving out the greater part of the lists of dynamos, motors, &c., manufactured by the leading electrical companies. The Kalender commences with short chapters on mathematics and physics, which are followed by a chapter on the main subject of the book, viz, electrotechnics; the first volume concluding with a short chapter of miscellaneous useful information on legal and other matters. The second part comprises chapters on more advanced mathematics and physics, and much useful information on electro-chemistry, and many valuable tables. Accompanying the Kalender are two valuable plates, one containing the magnetisation curve for cast-iron so as to show at a glance the number of lines of force per cm^2 produced by any given number of ampere turns; the other showing the cross-section of a bare copper wire required to carry a given current when the permissible rise of temperature is specified. Uppenborn's Kalender is more of the nature of a condensed text book on electrotechnics than the Molesworths *et hoc genus omne* that we are accustomed to in this country. It contains, therefore, matter which might be considered superfluous in the pocket book, but which might happen to be very useful where larger treatises are not available. The Kalender is, on the whole, well up to date, though we fail to find anything about Ewing's hysteresis meter, and Ewing and Ayrton's workshop methods of measuring permeability. England is not after all the only nation which is somewhat slow in recognising the progress of its neighbours.

CORRESPONDENCE.

Rudementary Facts about the Jandus Lamp.

We notice that three-quarters of a column in your last issue are devoted to a further tirade against the enclosed arc lamp.

Judging from the amount we pay you for advertisements, we really think this space might be employed more profitably to yourself. Really, Mr. Editor, it would save you money, and us valuable time, if you would send your office boy round to collect some of the rudimentary facts about the "Jandus" lamp.

After such a visit, he would be able to inform you that the constant current lamps for series working, taking 75 volts across the terminals, are in daily use; that the carbons are *not* more expensive than those used by other makers, although they burn 200 hours instead of eight; that where the lamps are used singly across 100 to 120-volt circuits, the proportion of watts utilised is greater than with two open arc lamps run in series across the same voltage, and that when used for street lighting, frequent tests have been made by reading a paper folded in the middle when standing midway between a "Jandus" and an open-type arc lamp, each consuming the same watts, the results being in favour of the "Jandus."

On his return, we venture to think that this intelligent member of your staff would have offered his unsolicited advice that your unsigned critic's vagaries should be committed to the W.P.B.

The enclosed arc lamp is bound to become universal, in spite of your sympathies for the past. Why not accept the inevitable and advance with the times?

Drake & Gorham.

May 11th, 1897.

Dynamo Design.

1st. What flux in C.G.S. lines per square inch can be allowed for practical use in best steel as got from ordinary steel foundries?

2nd. If you have a four-pole dynamo to get the same volts (only two sets of brushes being used) can the *area* of the poles be divided by two as compared with a two-pole machine, *i.e.*, to calculate voltage. With two sets of brushes do you count all the conductors round periphery of armature $\times$ by revolutions per second, and by flux through *two* poles and $\div$ by 10^8?

What I am puzzled with is how the increase of poles affects the voltage, and what difference cross-connecting the armature makes.

P. H.

[The effect of increasing the poles and cross connecting the armature conductors is to make the dynamo practically a bipolar machine, for all coils under similar poles are then connected in series.

The total flux is taken as equal to the flux from two similar poles; thus if the polar area of one N pole is 100 square inches, and flux is 500 per square inch, then flux is equal to $2 \times 100 \times 500$.

The multiplying of the poles has an advantage in cutting up the magnetic circuit into shorter paths.

A flux of 70,000 per square inch may be taken as a safe one for ordinary steel castings well annealed.—Eds. Elec. Rev.]

"Hydro-Electric Methods in Medicine."

In the Electrical Review of April 30th, there appears a friendly and instructive criticism of "The Hydro-Electric Methods in Medicine," in which the reviewer differs with me in the opinion I still hold, (1) that "total" resistance is all that concerns the question; (2) that in the light of later investigations Kohlrausch's method of 1880 is not reliable. I do not ask for space to enter upon a discussion of these points, but I would ask for "more light" on the following statement with reference to body resistance, which appears in the notice referred to:—"Owing to variation of the section, and probably, also, the specific conductivity of the human body, along its length, the only accurate method of getting at a correct result would be by a summation of the resistances of short sections of sensibly uniform conductivity." It appears to me that this statement, whilst it expresses a truism, advocates a method which is an impossibility; for no such portion of the body has uniform conductivity, and we cannot obtain living sections of the human body.

W. S. Hedley, M.D.

May 11th, 1897.

THE FRENCH PHYSICAL SOCIETY.

The Annual Meeting.

The French Physical Society held its annual sitting on Friday and Saturday, April 23rd and 24th, on the premises of the Société d'Encouragement, Paris. This réunion included exhibitions of the apparatus described during the year. On Thursday, April 22nd, a preliminary visit was paid to the works of the General Incandescence Lamp Company at Ivry.

In the Exhibition rooms were to be found the following apparatus, which were interesting from an electrical point of view. M. Abraham's induction oscillograph had been constructed by the firm of J. Carpentier, and was worked by the alternating current supplied by the Left Bank Sector. A series of very curious curves was observed, sometimes a regular sinusoid being formed, and sometimes a flattened sinusoid.

Messrs. R. Arnoux & Chauvin showed a number of electrical instruments; portable cases of controlling apparatus with aperiodic voltmeters and ampere-meters for measuring currents up to 1,000 amperes and electromotive forces to 600 volts, portable galvanometers with movable frame and mirror for laboratories, with universal sensibility reducer, two models of portable ohm-meters for direct readings for the rapid measurement of insulation resistances comprised, in one case, between 20 megohms and ·1 ohms, and in the other between 200 megohms and 1 ohm. These register with a circular pen, and are provided with clockwork mechanism, to drive the registering cylinder, and with an arrangement for the instantaneous placing and holding of the diagram paper.

M. André Blondel has also designed a direct sight double oscillograph for the study of alternating currents. This apparatus has been constructed by M. Pellin, and was working at the Exhibition.

M. R. Blot exhibited a collection of plates for his various types of accumulators, and also an element of 1,000 ampere-hours capacity.

M. L. Bonetti showed a radiographic apparatus with a Ruhmkorff coil and a new static cylinder machine for electro-therapeutics and radiography.

Messrs Cadiot & Co. showed various models of alternating current transformers, some small electromotors for X rays, some models of Bébé dynamos, and some electric ventilators and heating apparatus from the Société du Familistère de Guise.

The Cance Company exhibited various models of arc lamps, and an arc lamp for projections, and effected the lighting of the rooms by arc lamps connected with the company's private continuous current installation.

The Edison Continental Company has had constructed new registering amperemeters and voltmeters of a very small size, which give complete satisfaction.

The French Electrical Apparatus Company contributed various interesting exhibits. For instance, an automatic interrupter for primary high tension currents, an automatic lighter and extinguisher for temporary and variable duration, an automatic regulator of consumption of current, an interrupter for 500 volts, and interchangeable fusible wire circuit breakers for high tension currents of 500 to 5,000 volts.

We may also mention the Dinin accumulators, which are used in the ignition of the Dion petroleum tricycle, and M. Doignon's electro-motors, Messrs. Gaiffe & Co.'s transformers for transforming continuous currents into low frequency alternating currents, and Dr. D'Arsonval's milli-amperemeters and voltmeters.

M. Lioret exhibited a small phonograph which reproduced the voice loudly, and could be heard all over the room.

The Exhibition of the French Physical Society included a number of curious and interesting exhibits, but contained no real novelty.

LEGAL.

House of Lords Appeal.

On Thursday and Friday last week the Lord Chancellor and the Law Lords, sitting in the House of Lords, heard the appeal of Mr. Francis Gosling *v.* Messrs. Gaskell & Grocott. The action, which was originally heard before the Lord Chief Justice, was to recover the sum of £488 9s. 3d. balance of the price of goods alleged to have been sold and delivered between December 5th, 1893, and January 31st, 1895, to the appellant, and Mr. W. C. Gosling, since deceased. The respondents carry on business at White Hall Works, Longport, in the County of Stafford. The two Goslings were trustees of a deed of May 18th, 1892, made between Poole & White, London, carrying on business as manufacturers and vendors of electrical appliances. It was a mortgage deed for securing the payment of a second series of debentures of the company amounting to £3,000. It was made subject to a similar mortgage trust deed for securing a first series of debentures amounting to £7,000, taking priority over the second series. The two Goslings were members of the banking firm of Goslings & Sharpe, and the firm held all the second series of debentures as partnership property. Under a power in the trust deed, Mr. William John Kelly, the secretary of the company, was appointed Receiver with very wide powers. After the winding up order, Mr. Kelly continued to act as Receiver till 1895, when the first debenture holders interfered and put an end to the carrying on of the business. The liquidator never interfered at all. The short question, therefore, was whether the Goslings were liable as undisclosed principals for the goods ordered from the respondents.

Mr. Herbert Reed and Mr. Hansell argued the case for the respondents in support of the judgment of the Lord Chief Justice and the Court of Appeal. They contended that the applicant was the undisclosed principal of Mr. John Kelly, who conducted the business as their agent and upon their mandate for the benefit of the second debenture holders who received the proceeds or part of the proceeds.

Mr. Hamilton having replied for the appellant, the Lord Chancellor intimated that their Lordships would consider the case.

In Re the Thetford Electric Light and Power Company, Limited.

In the Queen's Bench Division of the High Court of Justice on Tuesday, before Mr. Justice Hawkins and Mr. Justice Wright, the matter of the Thetford Electric Light and Power Company, Limited, on the petition of Jackson, came up for argument. Mr. Grosvenor Woods, Q.C., and Mr. Stokes, were counsel for the appellant, Mr. Wm. Jackson, of Leeds, and Mr. Poyser appeared for the respondent Company.

Mr. Grosvenor Woods, in opening the case, said it was an appeal from the decision of the County Court Judge of Norwich, dismissing a petition for the compulsory winding up of the Thetford Electric Light and Power Company, Limited. Subsequent to the presentation of the petition a meeting was held at which the members of the company present purported to pass a resolution for voluntary winding up. It was alleged on behalf of the company that that resolution was a binding one, and the questions for their Lordships to determine were two: First, whether the resolution was valid—which counsel submitted it was not—and, secondly, if it was, whether under the circumstances of this case an order ought not to have been made upon the petition having regard to the affairs of the company. He (Mr. Woods) appeared for the petitioner, who held 175 out of the 368 shares subsisting in the company. His petition was presented before any resolution was passed, and they said that under the circumstances no effective resolution could be passed to voluntarily wind up the company.

The case occupied the Court on Tuesday and part of Wednesday, and having been discussed at great length, their Lordships dismissed the appeal with costs, and refused leave to appeal.

Goodman *v.* The Chelsea Electricity Supply Company, Ltd.

In the Queen's Bench Division of the High Court of Justice on Thursday, the action Goodman *v.* The Chelsea Electricity Supply Company, Limited, was set down for hearing before Mr. Justice Hawkins and a special jury. Mr. Crump, Q.C., with Mr. Lewis Thomas and Mr. Herbert, were for the plaintiff, Martin Goodman, of Harriett Street, Sloane Square; and Mr. Bigham, Q.C., and Lord Robert Cecil for the defendant company. Counsel for plaintiff stated that this was an action to recover damages sustained by Goodman at his premises in consequence of the defendants' negligence. At this stage the leading counsel asked for a little indulgence, and a moment or two later Mr. Bigham rose and intimated that the case had been settled, defendants agreeing that there should be judgment for plaintiff for £500 with costs. Judgment accordingly was entered, with a certificate for a special jury.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings. — The adjourned public examination of W. R. Ridings, electrical engineer, was held at the Birmingham County Court last week.

An application for an order of discharge was made last Wednesday at the London Bankruptcy Court by Ronald Hope Bridie, engineer, St. Benet's Place, Gracechurch Street, City. The bankrupt was in the employment of electrical engineers from 1888 to 1891, and in the latter year he commenced business on his own account. He was brought to the Court last August with liabilities £2,149 6s., and assets that realised £47 16s., sufficient to pay the creditors a divided of 2⅜d. in the £. The failure was entirely attributed to speculative losses on the Stock Exchange, amounting during the 12 months preceding the failure to £2,300. Mr. Registrar Giffard imposed a suspension of two years and three months.

Calendar.—The Chloride Electrical Storage Syndicate, Limited, has issued a very fine calendar for the current year, which is of such a size as to be suitable for the frame sent out by the company last year with the 1896 calendar. The design is interesting, the principal feature being a full-size illustration of a standard R type chloride plate. There are several small photographs showing various uses of accumulators.

Catalogues.—Messrs. Doulton & Co., of Lambeth, have issued a new catalogue (No. 47) of their electrical conduits and accessories, which are made to comply with the Revised Board of Trade Regulations for high pressure or low pressure conductors. The conduits are made of hard-burnt glazed stoneware. The method of laying Type A and D casing, also of making house services, &c., are dealt with, and various other types are described and priced, including stoneware drawing in blocks, glazed stoneware pipes, street boxes, ventilating boxes for street boxes, insulators for bare copper mains. The mains supplied and laid at Leyton are also described.

The Phœnix Dynamo Manufacturing Company of Bradford send us lists of their continuous current dynamos and motors, and a card of tabulated information *re* sizes and capacity of conductors, useful to electrical engineers.

Electrical Wares Exported.

Week Ending May 11th, 1896.	£	s.
Adelaide	120	0
Amsterdam	230	0
„ Teleg. mat.	37	0
Antwerp...	30	0
Bangkok	121	0
Bombay	12	0
Brisbane	6	0
Buenos Ayres	547	0
„ Teleg. mat.	53	0
Callao	26	0
Calcutta	173	0
Cape Town	550	0
Copenhagen. Teleg. cable	1,771	0
Delagoa Bay	170	0
Durban	164	0
East London	1,497	0
Flushing. Teleg. mat.	40	0
Grenada...	37	0
Hamburg	350	0
„ Teleg. mat. ...	470	0
Hong Kong	99	0
Las Palmas	50	0
Passages...	97	0
Paris	643	0
Port Elizabeth	133	0
Rockhampton	97	0
Rotterdam. Teleg. wire	28	0
Rosario	187	0
St. Petersburg	150	0
Shanghai	228	0
Singapore	56	0
„ Teleg. wire	33	0
Stockholm. Teleg. wire	12	0
Sydney	360	0
Teneriffe	9	0
Wellington	45	0
„ Teleg. mat.	229	0
Yokohama	40	0
„ Teleg. mat.	70	0
Total	£8,970	0

Week Ending May 11th, 1897.	£	s.
Albany	297	0
Amsterdam	225	0
Antwerp. Elec. fuses...	361	0
Bangkok	772	0
„ Teleg. mat. ...	913	0
Beira. „ „ ...	64	0
Bilbao. „ „ ...	14	0
Bombay	438	0
„ Teleg. mat. ...	46	0
Brisbane. Teleph. mat.	721	0
Brussels	1,230	0
Calcutta	194	0
Cape Town	10	0
Colombo	322	0
Copenhagen. Teleg. wire	17	0
Durban	986	0
„ Teleg. mat.	179	0
East London	98	0
Galveston	8	0
„ Teleg. cable...	2,800	0
Genoa	300	0
Hamburg. Teleg. mat.	1,229	0
Hong Kong	25	0
Madras	96	0
Marseilles	163	0
Mauritius. Teleg. mat.	120	0
Melbourne	61	0
Nagasaki. Teleg. cable	25,000	0
Passages...	1,710	0
Port Elizabeth	130	0
Shanghai	823	0
„ Teleg. mat. ...	80	0
Singapore	51	0
„ Teleg. mat. ...	332	0
Sydney	314	0
Trieste. Teleg. mat. ...	330	0
Trinidad	13	0
Vigo. Teleg. mat. ...	268	0
Wellington	25	0
„ Teleg. mat.	2,471	0
Yokohama	150	0
Total	£43,386	0

Foreign Goods Transhipped.

	£	s.
Brisbane	122	0
Buenos Ayres	55	0
Total	£177	0

	£	s.
Calcutta. Teleph. mat.	75	0
Port Elizabeth	38	0
Total	£113	0

Continental Branch.—Messrs. W. T. Glover & Co. have opened an office in Brussels, with Mr. Douglas Wells, M.I.E.E., as manager for Belgium and Holland.

Fuel Cost Calculator.—We have received one of Messrs. Meldrum Bros. very useful fuel cost calculators, of which we gave particulars a few weeks ago.

Gas.—On 7th inst. a severe gas explosion occurred at Hamlet Road, Norwood, a leakage being sought for in the usual manner.

Guilty.—At the Central Criminal Court, last week, the Recorder convicted George Fowler, for receiving a quantity of cable and electrical appliances, the property of the Electrical and General Engineering Company, of Leadenhall Street. An employé of the company, named Jackson, is now undergoing sentence for stealing the property, and the *City Press* says that he was the principal witness against Fowler. Sentence was postponed until next sessions.

Horsfall Destructors.—We understand that the Judges of the Sanitary Exhibition at Newcastle-on-Tyne having selected the Horsfall Company's patent refuse destructor for further practical trial, have now completed their tests, and have awarded that company the silver medal of the Sanitary Institute.

Installation Work.—Messrs. Russell & Russell inform us that they are very busy with electric wiring work just now, having in hand the following among other buildings:—Clerkenwell Fire Station, for the L.C.C.; Hammersmith Lighting Station, for the Hammersmith Vestry; 29, Great Cumberland Place, for Sir Wm. Clayton; the National Penny Bank, Oxford Street; the Westminster Conservative Club; "Hillwood," Sydenham, for Franco. Torromé, Esq.; Weatherby Mansions, S.W.; The Mansions, Richmond Road, S.W.; Bramham Mansions, S.W.; Welbeck Mansions, N.W.; Willis's Restaurant; the "Diamond Reign" Hotel; Inkerman Barracks, Woking, for the War Department; also work at Ealing, Richmond, &c.

International Inventions Exhibition, London, 1897.—In August and September of this year, an International Exhibition of Inventions and Improvements relating to Science, Industry, Arts and Crafts, Hygiene and Alimentation, takes place at the Marlborough Hall, Polytechnic Institute, Regent Street, London, W. All applications to be addressed to the offices of the Exhibition, 18, Hart Street, London, W.C.

Jubilee Illuminations.—The Admiral Superintendent of Devonport Dockyard has been instructed to forward to Portsmouth a large number of electric incandescent lamps, signal lanterns, and coloured lights for distribution among the ships which are to assemble at Spithead for the review by the Queen next month. At night the ships will be illuminated with yard-arm, masthead, and bow and stern groups of electric lights, and several series of 16-C.P. electric lamps in lines fore and aft and athwartships, and from truck to water-line coloured lights of all descriptions. The cost of the decorations is estimated at £10,000.

Lund Bros. & Co.—Referring to our paragraph under "Liquidation Notices" last week concerning this firm, we are informed that it would be more correct to say that their firm *has amalgamated* with Messrs. Ashwell & Nesbit. The "taking over" is only part of the legal arrangements. For the last 18 months the steady growth of the business carried out by the two firms conjointly has led to the consideration of the question of amalgamation, which is thought to be advantageous to both firms.

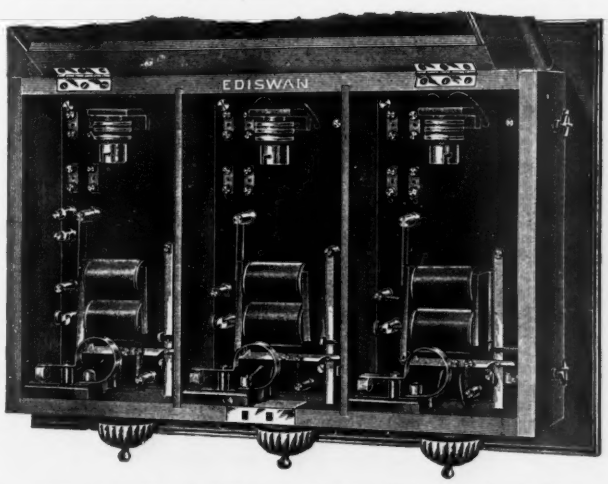
Lyon's Liquid Resistances.—The General Electric Co., desire us to make it known that by an inadvertence an mission was made in their advertisement of last week of the above speciality of theirs, viz., it should have been stated that the improvements to which they refer are not an integral part of the Lyon's Liquid Resistance, but accessories designed for that purpose by Mr. E. Wingfield Bowles.

Partnership Notice.—Mr. J. Birnie Evans, A.I.E.E., has retired from the firm of Donnison, Berlyn & Co., and will take charge of their North of England branch. The firm has taken into partnership Mr. William Sillem, Assoc.M.Inst.C.E., and the name in future will be Donnison, Berlyn, Sillem & Co. We are informed that Mr. William Sillem has for the last few years been engaged on the engineering staff of the Metropolitan Electric Supply Company.

Provincial Installations.—The Liverpool Gas and Electric Fttings Company, Limited, are very busy in their electrical department, having the following work in hand:—For Upton Asylum, Chester, an installation consisting of three 50-horse vertical engines by Messrs. Browett Lindley, and three 35-unit Jackson's dynamos direct coupled; 1,800 16-c.p. lamps distributed over a very large area, necessitating overhead mains. Prince of Wales Hotel, Harrogate, an installation consisting of one 40-horse Premier gas engine, one 25-unit Taunton dynamo, two sets of Epstein accumulators, 600 16-c.p. lamps. Ashworth's Buildings, Manchester, installation consisting of two Stockport engines and two Jackson's dynamos, belt-driven heavy fly-wheel, countershaft between; 400 16-c.p. lamps. Spring Gardens, Manchester, an installation consisting of two Stockport engines and two Jackson's dynamos, belt-driven heavy fly-wheel countershaft between; about 400 16-c.p. lamps. For Messrs. Ayrton & Saunders, Liverpool, wiring and fitting for 200 16-c.p. lamps.

Robertson Lamps.—The General Electric Co., Ltd., has had a most effective show card designed specially to push the sale of the "Robertson" lamps, which are made at the company's works, Brook Green, Hammersmith. The show card, which is a fine example of colour printing, is 2 feet × 1½ feet, and it is mounted in a neat frame with a plate glass front, the whole making a very handsome picture.

Ship's Light Indicator.—We illustrate Martin's patent type of ship's light indicator, which is made by the Edison and Swan Company. Being fixed in the captain's cabin, it enables him to see at once when any of the lights fail, and dispenses with a man continually watching. This indicator is claimed to be far more reliable, and far cleaner than the old fashioned oil lamps, while at the same time it occupies less space, and gives more light. Double filament lamps are fixed on the starboard, masthead and port,



coloured to the Board of Trade regulations. When switched on, the current flows through the coils into *one* filament of the lamps. Immediately any one of the lights fail, the reserve filament comes into use, and the indicator in the captain's room indicates by lighting up and showing which lamp has actually failed, at the same time ringing a large bell. The bell can be stopped, but on no account can the lamp in the indicator be put out until a new lamp is put in the port light, or wherever it may be. To see that all is in order before switching on the lights, it is only necessary to press the small buttons by each tumler switch at the bottom of the indicator.

Summons.—Last week, an Electric Light Company, of Moorgate Court, were summoned at the South-Western Court, at the instance of the Vestry of St. Mary's, Battersea, for breaking up and opening Trinity Road, Battersea, without giving three days' notice to the Vestry. It was explained that the company had statutory powers for the lighting of the Wandsworth district, but had been refused leave by the Battersea Vestry to lay their mains in Battersea district. They carried out the work in the dead of night. It having been mentioned that there was an action pending in which the Vestry were seeking to obtain an injunction against the company, the summons was adjourned *sine die*.

Tasmanian Copper.—At the statutory meeting of the Tasmanian Copper Company, last week, the chairman stated that the mines and works at Tasmania were now being laid out. The motive power would be derived from water, and transmitted by electricity. The necessary surveys for the water ditches from the Pieman and Stitt Rivers are in process of being made.

The Sheffield Electric Light and Power Company, Limited.—The business of the Universal Electrical Fittings Company, Limited, Suffolk Road, Sheffield, has been acquired by the Sheffield Electric Light and Power Company, Limited, and all moneys due to, and owing by, the Universal Company, Limited, will henceforward be received and discharged by the Sheffield Company.

The Electrical Trades in Austria.—Consul Haggard, in a report to the Foreign Office on the trade of Trieste for 1896, says:—"Instruction in all branches of electricity has been instituted during the year at the Government Industrial School. Machinery and plant upon a very liberal and expensive scale has been provided from several parts of Europe. It is evident that this branch of technical instruction is considered one of great importance, and that every attempt is being made to give the widest opportunities to students in Trieste. In view of the numerous applications from tradesmen, merchants, and others in England, some remarks on the advertisement of goods may not be without importance. I believe that the various trade catalogues, prospectuses, lists, &c., sent to Consuls, are of very little, if any use, when printed in the English language, except to countries where the English tongue is used. When printed in the language of the nation for which they are intended, they are perhaps of a certain but limited value, if the protective duties of that country will admit of the introduction of British goods at a profit, which, as a rule, is not the case now in Austria, where the cheaper articles of home production are at present preferred to ours, though the latter are acknowledged to be very superior. For the last four years I have, under an arrangement with the president of the Chamber of Commerce, sent regularly to him the majority of such publications, to be deposited on the public table of the Exchange, where they cannot fail to be seen by all merchants and others likely to be interested, for in the British Consulate itself they are never asked for. But I have reason to think that even in the Exchange those in English are seldom ever consulted, although the Chamber of Commerce has undertaken from time to time to call the attention of merchants and others to them. I believe that one competent traveller pays far better (when the duties will permit importation) than double the amount of money invested in catalogues, &c. The expense of translating such works, too, is often as useless as it is great. For instance, in this immediate neighbourhood, the Italian, German and Slav languages—the latter of different dialects—are all spoken. But so great is the feeling in regard to language that, generally speaking, those who would perhaps read a catalogue in one of those languages, would simply refuse to look at it in another, although they could understand it, and I cannot, therefore, see how any translated catalogue can ever really pay well under such circumstances, although certainly the number of these publications which still continue to arrive points to the contrary. My conclusion is, however, the result of considerable experience."

Vaughan v. Vesey.—In the Westminster County Court, on Monday, this case was disposed of by his Honour Judge Lumley Smith, Q.C., being a claim for £22 11s. 8d. for work done and goods supplied by Messrs. Vaughan & Brown, Limited, electrical engineers, &c., of Hatton Garden, E.C., for defendant, in connection with a cinematographe he was exhibiting at the Royal Holborn Music Hall. Mr. Geo. Charles Vaughan, M.I.E.E., said he was director of the plaintiff company and manager of the electrical department. In October last he was superintending some London County Council requirements at the Royal Holborn Music Hall for Mr. Brill, the proprietor, when Mr. McKay Robertson asked him to have a look at Mons. Vesey's cinematographe. Witness told him it would require two resistances before it worked properly. He ordered them on M. Vesey's behalf, and £2 9s. was charged for them. Also, at Robertson's request, a man was supplied to work the machine, whose time came to £11 16s., and £8 6s. 8d. was charged for witness for supervision. The machine would not have worked had it not been for the resistances. His Honour, in giving judgment for the plaintiffs for £17 with costs, said he was allowing Mr. Vaughan something for supervision, but not the amount claimed.

ELECTRIC LIGHTING NOTES.

Australia.—Mr. J. O. Callender has furnished the Moree Council with an exhaustive report, together with an estimate of cost, with regard to the proposal to light the town by electricity. For lighting intersections of streets, groups of five or six incandescent lamps of 25 C.P. were recommended to be placed at the intersections. The street lighting service, altogether, consists of 22 single lamps of 25 or 32 C.P., and nine groups of five or six lamps each of 25 C.P., with two groups of 25 candle-power lamps on the bridges. Relative to the private lighting, the report estimates that it would be necessary to obtain subscribers for 300 lamps of 16 C.P. If that number be not obtained, the Council is advised not to proceed with the matter at present. Two schemes were submitted, one costing £4,326, the other £3,798.

Bedford.—At the Council meeting on 6th inst., it was decided to make application to the Local Government Board for their sanction to the borrowing of the further sum of £20,000 for the purpose of making additions to the existing buildings and machinery, and providing and laying mains. The sewage pumping machinery is to be worked by electricity. The proposed new machinery includes two additional boilers, with mechanical stokers and steam piping, £1,677; one additional engine, alternator, and exciter, of a capacity of 250 units, £2,500.

Belfast.—The Electric Committee has referred the tenders which have been received for the various works in connection with the new electric light station to the engineer for report at the next meeting.

Brighton.—The Lighting Committee have resolved that the resolution of March 29th last directing three months' notice instead of one month's notice to be given to consumers of electricity of the intention to make a minimum charge for electricity, and that the charge be a quarterly minimum of 7s. 6d. instead of an annual minimum, shall be rescinded, and that three months' notice be given to consumers of the intention to make a minimum charge of 30s. per annum for electricity, such charge to be at the rate of 15s. per half year. Where consumers give notice to have their meters removed for a portion of the year a charge of 10s. will be made for so doing.

Bristol.—The Public Electric Lighting Committee brought up a report at Tuesday's Council meeting on the extension of public lighting, and stated a number of thoroughfares which, in its opinion, should be electrically lighted. About 200 arc lamps will be required for this purpose; 103 arc lamps are now in use, and their cost is about £35 per lamp per annum, or £3,690 per annum. The cost of lighting by gas the streets now proposed to be lighted by electricity is about £2,400, making, with the sum of £3,690, a total cost for lighting of £6,090. "Your committee are informed by the Electrical Committee that if 200 additional arc lamps were erected, the cost of the 303 lamps (inclusive of the provision and maintenance of machinery and plant, the generation of electricity, and all other expenses), would not exceed £23 per lamp per annum, or £6,969 per annum. This sum would exceed by only £879 the present cost of lighting, amounting to £6,090, as before mentioned; whilst the illumination of the streets now lighted by gas would be very considerably increased. In these circumstances your committee recommend the Council to authorise the Electrical Committee to light by arc lamps the streets forming the routes above specified, and to authorise your committee to discontinue the use of gas in such streets."

The Town Council discussed the proposal at considerable length, and a good deal was said in favour of gas, but ultimately the proposal to light the streets electrically was adopted without a division.

Bury.—There was a short discussion at last week's meeting of the Town Council with regard to the price charged for the electric light. According to Councillor Sykes, the Council are dissatisfied with the slow way in which the light is being taken up. Councillor Ashworth said that they commenced to offer the electric light at the same price as Manchester, and by development they would no doubt come to see it was wise to follow the steps of Manchester and reduce the price.

Cheltenham.—The minutes of the Lighting Committee, which came before the Council last week, showed that the electrical engineer (Mr. Kilgour) had prepared an estimate of the cost of substituting arcs for the incandescent lamps originally proposed for the Bath Road. If the arcs are spaced on the average 65 yards apart, which he considered would give ample light, the cost of the change would be £400, and for this sum a loan would be required. The number of lamps would be 23, and if the average distance between the lamps be reduced to 60 yards, the additional cost of the necessary two arcs would be £72. A letter had been received from Mr. R. P. Sellon, on behalf of the Brush Electrical Engineering Company, Limited, stating that his attention had been called to the fact that the committee demurred to the payment of that part of their invoice of March 17th, which amounted to £20 12s. 6d., for modifications introduced into certain arc lamps which the company recently supplied to the Corporation, and that having looked into the matter, the writer found the modifications were the outcome of useful suggestions made by Mr. Kilgour, and that the lamps as modified had proved to be an improvement in the class of arc lamps required for municipal purposes. These modifications had been introduced by his company into all lamps since ordered from other sources, and under these circumstances his company begged to withdraw their invoice above referred to, and desired to express their indebtedness for the suggestions received from Mr. Kilgour. The minutes were approved by the Council. The lamps will be placed on an average 65 yards apart.

Darlaston.—The premises of Mr. Wynn, in Pinfold Street, are now lighted by electricity, 40 16-C.P. incandescent and two 1,000 C.P. arc lamps being used. A 4 H.P. Tangye engine drives a dynamo, the plant having been put down by Messrs. Fellows, Wheatcroft & Co., of Walsall.

Dundalk.—The Commissioners' electric lighting provisional order passed through the Committee stage on Friday last, and was reported for third reading.

Durban (Natal).—At the Durban Town Council meeting early in April, it was stated that Mr. F. H. Hadfield, the consulting engineer, had reported to the Electric Light Committee that the arc lamps sent out by the contractors were not the Brockie-Pell, as specified under the contract, and tendered for by them. A letter was read from Mr. J. Roberts, representing the contractors, the Electric Construction Company, Limited, intimating that the arc lamps supplied were according to specification and of the latest pattern. The Committee directed, says the *Natal Mercury*, that the representative be informed that this Corporation, while insisting on the correctness of their specification for Brockie-Pell lamps, is willing to accept the use of the lamps as sent out by the Electric Construction Company, Limited, pending the arrival of the Brockie-Pell lamps specified, but not otherwise; further, that Mr. Roberts be referred to the specification of lamps.

Dundee.—For the 12 months ending in April the sum collected for electricity rental was £5,542 13s. 6d.—an increase of £660 10s. 8d. The Gas Committee will advertise for tenders for coal supplies for the electric light station.

Edinburgh.—The Electric Light Committee recommends the Council to increase the salary of the resident electrical engineer (Mr. Newington) from £400 to £500 per annum, and that of the superintendent of mains from £200 to £240. Upon the recommendation of Prof. Kennedy, the committee also recommends authority to proceed with works and furnishings in connection with the change over to the new voltage system at a cost for the present of £1,600.

Elland.—The District Council has appointed a sub-committee to go into the question of lighting the town by electricity.

Haltwhistle.—A letter from Mr. F. J. Warden-Stevens, London, offering his services as engineer to the District Council for electric lighting in the town, has been referred to the Lighting Committee.

Hastings.—Last week the Town Council decided to purchase the undertaking of the Hastings and St. Leonards Electric Light Company for the sum of £58,000. The total capital expenditure of the company was £55,290. On the question of purchase the voting was 14 to 3.

Holbeach.—Tenders are to be invited by the District Council for street lighting. A proposal by a member that Jubilee year be celebrated by introducing the electric light was greeted with laughter.

Hull.—A Local Government Board inquiry was held on 7th inst. respecting the Corporation's proposal to borrow £52,000 for electric lighting extensions.

Ipswich.—In the House of Commons, on Friday last, the Electric Lighting Provisional Order (No. 1) Bill was read a third time.

Kalgoorlie (Australia).—It is stated that the municipal council has decided to borrow £10,000 for electric lighting purposes. The council prefers to carry out the work rather than to grant the right to capitalists who have applied for the necessary permission.

Kensington.—Approval was given by the Vestry of St. Mary Abbotts, Kensington, at the meeting on the 5th inst., to plans submitted by the Notting Hill Electric Lighting Company for extensions of mains in Kensington Park Gardens, and by the House-to-House Company, for extensions in Tregunter Road and Gilston Road.

Kirkby-in-Ashfield.—Mr. W. J. Furse's estimate for lighting the parish with electricity has been referred to Committee. He proposes to erect 189 lamps, and fit the works against the mill with two boilers and two steam alternators, with suitable exciters, at a cost of £9,500.

Lewisham.—At a meeting of the District Board of Works on Friday the chairman reported that the Blackheath and Greenwich District Electric Lighting Company, Limited, who were applying for a Provisional Order which contained clauses of importance to Lewisham, had agreed to the terms suggested by the Board, a reduction of 10 per cent. on the cost of lighting public lamps, and agreeing that that Board's making up of any deficiency of dividends in the case of the purchase of the undertaking should be limited to 5 per cent. for one year, and that the area of the Electric Company's operations should be limited to the Blackheath division. The Board then gave their consent to the granting of the Provisional Order by the Board of Trade.

Leyton.—Prof. Hy. Robinson has reported that Messrs. Siemens Bros. have completed the period of maintenance under their contract. There are now 123 public lamps lighted by electricity, seven of which have 32-C.P. lamps in them. The extensions of the central station plant are practically completed, and with the exception of one engine and dynamo they have been in use for some time. The statement of accounts by the resident electrical engineer, in respect of the year ended March 31st, 1897, being a period of six months 22 days, has been submitted. He reports that the outlook for the present year is hopeful, and that there is every prospect of a large increase in the sale of electricity. He has submitted to the Committee a scheme for extension of the electric mains through Fairlop Road, Hainault Road, Vernon Road, and portions of Lemna Road, and reports that there is every prospect of such extension bringing in a substantial revenue, based only on the consumption by customers who have already intimated their desire to be connected. The revenue, including receipts from street lighting, will, it is estimated, be not less than £400 per annum, and the total cost of laying the additional mains ready for connection to street lamps and consumers' residences is estimated at £1,230. The Committee recommend that the proposed extensions be carried out, and that application be made to the Local Government Board to sanction a loan of £1,230, the estimated cost of the proposed mains. In addition to this amount, a sum of about £450 will be required for providing labour, material, &c. The number of units generated during the month was 13,464, and the units sold 7,998·5. The report was adopted.

The Leyton School Board have resolved to light their new schools in Newport Road by electricity.

Liverpool.—St. John's Market is to be lighted with electricity at a cost not exceeding £900.

London.—No objections were raised by the Vestry of St. George, Hanover Square, at the meeting on the 6th inst., to the notices from the London Electric Supply Corporation, of intention to lay distributing mains in Bolton Street, and from the Westminster Electric Supply Corporation of intention to lay mains across Lupus Street, at the corner of Moreton Terrace.

Northampton.—A report has been received from the borough engineer as to the cost of present gas lighting in comparison with the offer of the Electric Light Company. The gas lights in question cost £216 19s. The 16 arc lamps proposed to be substituted giving 32,000 C.P., would be £376 per annum, and if lighted all night at full power, £540. The Lighting Committee recommended that the Market Square, The Parade, Drapery, Mercer's Row, George Row, Wood Hill, and St. Giles's Square, be lighted with the electric light in lieu of gas. The matter was referred back for further consideration.

Paisley.—On Monday the Commissioners decided by 20 votes to 3 to adopt the Electric Lighting Committee's recommendations *re* lighting stated streets with 61 arc lamps of 2,000 C.P. each, the Commissioners to pay £20 per lamp per annum.

Spain.—Tenders were recently invited for the concession for the electric lighting of the public streets of Carrion de los Corde (Palencia Province) during a period of 20 years; but, says a correspondent, not a single offer was received.

Tonbridge.—The Electric Lighting Order has been passed, and now remains for confirmation in the next Session of Parliament.

Torquay.—The Council has decided that the charge for electricity shall be fixed at 7d. per unit for the first hour, and 3d. per unit afterwards, with meter rents at 2s. 6d. per quarter for every 50 8-C.P. lamp, or fraction thereof. The laying of the electric light mains commences in a few days. The Corporation has resolved to charge 7d. per unit for the first hour and 3d. per unit afterwards.

Wakefield.—The Electric Lighting Committee has recommended the appointment of Mr. J. K. Brydges (for some time past connected with the Yorkshire House-to-House Company at Leeds) as electrical engineer to the Wakefield City Council, at a salary of £200 per annum. It is expected that the Wakefield electricity supply will be ready in the autumn.

West Hartlepool.—The Town Council has now decided to go in for electric lighting, and will engage an expert to advise as to the system, site, cost, &c. A Committee has been appointed to carry the matter through.

Walsall.—The Council has adopted the report of the Electric Lighting Committee which recommended that each consumer be charged only 2d. per unit (instead of 6d.) for all electricity over the maximum, their maximum being calculated twice a year.

Whitechapel.—The Whitechapel Board of Guardians have decided to call in a competent electrical engineer to furnish the Board with a report upon the proposal to light the Workhouse and Guardians' Offices electrically. The Board of Works has appointed a sub-committee to inspect electric light stations in London and elsewhere.

Wolverhampton.—The Lighting Committee has resolved to supply electric current for illuminating purposes during Jubilee week at half the usual rates.

The Local Government Board has sanctioned a loan of £1,097 for electric lighting purposes.

Worcester.—The Council has adopted all the recommendations made in Mr. Ruthven-Murray's report, to which we recently referred, with the exception of the one relating to a reduction in the charge for the supply to the waterwork's motors. The following have therefore been adopted:—The alteration in tariff from 5d. per unit to 6d. per unit for the first hour's daily average use, and 2½d. per unit for all extra. All discounts have been abolished, and free lamps are to be given in lieu thereof for prompt payment. The charge for current to motors and cooking apparatus has been amended. Meter rents have been reduced 50 per cent. all round, and the Council is now entering into an agreement with the Free Wiring Syndicate for the free wiring of consumers' premises. The whole of the extensions recommended by Mr. Ruthven-Murray, at an estimated cost of nearly £9,000, are to be carried out.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Bristol.—Preparations are in progress for laying the electric tramway to be authorised by the Bristol Tramway Company's Bill now before Parliament, namely, the extension of the Eastville section from that point to Fishponds and Staple Hill, a distance of 2¾ miles, making this section altogether 4¼ miles in length. The material for the new track has already been ordered. It is hoped that the extension from Eastville to Fishponds will be completed by the end of August, as there will be only the outdoor work to be done of laying the track—all the necessary power being ready to hand at the company's electric power station at St. George's.

Cardiff.—The Council has appointed a small committee (consisting of Alderman Carey, Councillor Hallett, the boro' engineer, and the electrical engineer), to visit places where electric tramways are in operation, for the purpose of getting information as to the best means of providing the energy for and working the proposed tramways, and also as to the best systems of traction. The original proposal was to send a larger deputation, but the Council thought this unnecessary.

Cork.—The application of the Cork Electric Tramway Company for an order changing their title to the Cork Electric Tramway and Lighting Company, was favourably reported upon by the Judicial Committee of the Privy Council sitting at Dublin Castle last week. Since obtaining their previous order, the company have obtained a lighting order from the Corporation, and this necessitated the present application.

Derry.—Last Saturday, the Corporation opposed the renewal of an order empowering a company to lay down a system of electric tramways in some of the principal streets of Derry. The Privy Council over-ruled the opposition. The company (the City of Derry Tramways Company) were really applying for a renewal of the 1893 order, or for an extension of time. The nominal capital was £10,000, but the money had not yet been subscribed.

Dover.—The Council last week resolved to pay £5,500 to Messrs. Dick, Kerr & Co. on account of their contract for the supply of the tramway metals. The permanent way contractor requested a payment of £200 on account, but as the surveyor expressed himself not satisfied with the progress of the work, it was decided to make no payment at present.

Dublin.—In a few days, says the *Freeman's Journal*, the Bill of the Dublin United Tramways Company will come before Parliament practically unopposed so far as the Dublin Corporation and the suburban townships are concerned. The company have made satisfactory arrangements with all these representative bodies, and if the Bill passes—and there is little doubt it will—the company will then have to decide upon what line or lines they will begin operations for superseding the horse traction by electric power.

Dundalk.—The Judicial Committee of the Privy Council, sitting at Dublin on Saturday last, had before it an application for an order authorising the construction of an electric tramway between the town of Dundalk and the village of Blackrock, four or five miles distant. The Committee decided to report in favour of the whole scheme, subject to agreement with certain objectors.

Hull.—In our last issue we abstracted the report of the tramways deputation recommending the adoption of the trolley system for the lines which the Corporation has purchased. The cost of the equipment will be about £225,000. At its last meeting the council adopted the committee's recommendations.

Isle of Thanet.—The Light Railway Commissioners, of which Lord Jersey was chairman, held an inquiry on Monday as to the proposal to construct a light railway to be worked by electricity in the Ramsgate district. The principal opposition emanated from the owners of pleasure vehicles, and a few persons who thought a light railway on the sea front might interfere with the charm of the scenery. Evidence being given for and against the scheme, the Commissioners reserved their decision.

At a special meeting of the Broadstairs and St. Peter's Urban District Council held to consider the proposed Isle of Thanet light (electric) railway, the chairman (Councillor J. T. May), stated that a deputation had been to Dublin for the purpose of seeing the electric light railway at work there, as it was practically the same as it was proposed to introduce into the Thanet district. The deputation saw the railway at work from a place called Dalkey, on one side of Kingstown, and right through Kingstown, which was a suburb of the City of Dublin. The electric railway did not go into the busy part of Dublin, but it was proposed to extend it. The company had eight miles of electric tramway, and in addition they were the owners of the horse tramcars there, and had over 1,600 horses at work. The deputation made a great deal of inquiry among residents and tradesmen and found the electric tramways very much appreciated. The deputation also visited Birmingham, where they saw not only electric tramcars but steam tramcars, cable cars, and also the electric accumulator system, where the electricity had to be stored for the journey, and that was objectionable, as the provision to be made for the storage added to the weight of the cars. The accumulator system was only worked for about two miles. The city officials at Birmingham were very courteous to the delegates, and presented each one of them with a book containing the reports of a deputation which they had sent out to visit various towns in connection with this matter. The deputation also saw a gentleman who had visited places abroad, and it was found that wherever electric tramcars were running everyone seemed to encourage them. The Council then resolved itself into a committee to consider details in respect of the official inquiry to be held in respect of the scheme.

Liverpool.—A meeting of the City Council was held on 7th inst. to receive the report of the special Tramway Committee, and to consider a recommendation to the effect that the committee be authorised to inquire into and report as to the best means of improving the tramway service of the city. A Bill has already been passed in Parliament sanctioning the purchase of the tramways by the Corporation, which will take possession on August 31st, 1897. Sir Arthur Forwood, chairman of the committee, made a lengthy statement, reporting as to the investigations they had made. He briefly referred to the question of mechanical power with special reference to electricity. The cost of the purchase was in round figures about £575,000, and to reconstruct and equip these lines for some kind of mechanical traction would bring the cost up to £1,000,000 or £1,300,000 according to the system of power employed. The motion empowering the committee to inquire into the matter, with the aid of such professional advice as they might consider necessary, was carried. The names of the committee are:—Sir Arthur Forwood (chairman), Aldermen J. B. Morgan, A. Garnett, J. Miles, W. H. Williams, Cookson, Houlding, and Fred. Smith. Councillors W. Oulton, R. Kelly, Isaac Turner, E. Purcell, H. Campbell, W. J. Burgess, G. J. Lynskey, W. C. Williams, W. H. Edwardes, W. W. Rutherford Petrie, John Wilson, and Sir David Radcliffe.

Milan.—In the course of a report to the Foreign Office on the trade of Lombardy for 1896, Consul Armstrong says: The Edison Company of Milan, which was formed for the purpose of supplying electric light and apparatus, has, in consequence of the arrangement come to with the municipality for working the city tramways from the beginning of 1897, increased its capital, which now amounts to £360,000. The tramways, which were previously owned by a company, have been taken over by the municipality from January 1st, this year, and they are to be worked by electricity on the overhead trolley system. The Edison Company, which I have already mentioned in connection with electric lighting, is to work the lines and to provide the motive power and its adjuncts, the cars, and the personnel at its own expense. The lines are to be provided and kept in order by the town. The company is paid at the rate of 3·80d. per mile for every independent car, and 1·94d. per car mile for each trailed car. On the other hand the company pays the town a rent of £180 a year for each mile of single line. The takings are cashed by the municipality, which pays the company what it is entitled to under its car-mile rate. After deduction of this, and of the amount due to the town for rent of the lines, the remainder is to be divided between the municipality and the company, in the proportion of 60 per cent. to the former and 40 per cent. to the latter. It is calculated that this arrangement will bring into the town a net yearly profit of at least £30,000. There are at present in the town 42 miles of single line, and in 1896 the then tramway company carried over 35,000,000 paying passengers. The tariff is 1d. from the centre of the town to the suburbs, and it is intended for the convenience of workmen to run cars at half price for an hour in the morning and an hour in the evening. The servants of the company engaged on the cars are not to work more than 10 hours a day, and are to have four holidays a month. As yet only one line is being worked by electricity, on the other lines the traction is still being done by horses, but the new system is to be extended to the other lines as rapidly as possible. I have entered into all these details of what is really a purely local arrangement in the hope that they may be of some interest to such towns in the United Kingdom as are contemplating the taking over of tramways.

Motor Cars.—Heavy Fines.—On Monday, at the Warwick Borough Police Court, Alphonse Deniot, of Coventry, was fined £15 and £3 13s. costs for three separate offences against the bye-laws in driving a motor car at an unreasonable speed, failing to display a light, and refusing to stop when requested by a constable.

Swansea.—A South Wales paper says that Lord Kelvin visited Swansea on Friday last, and made a careful examination of the borough tramlines with a view to giving evidence for the Corporation Bill now before Parliament. He was accompanied by Mr. E. Manville, who is advising the Corporation, and drove to the site of the proposed dust destructor, and also obtained all the information possible on the electric lighting scheme.

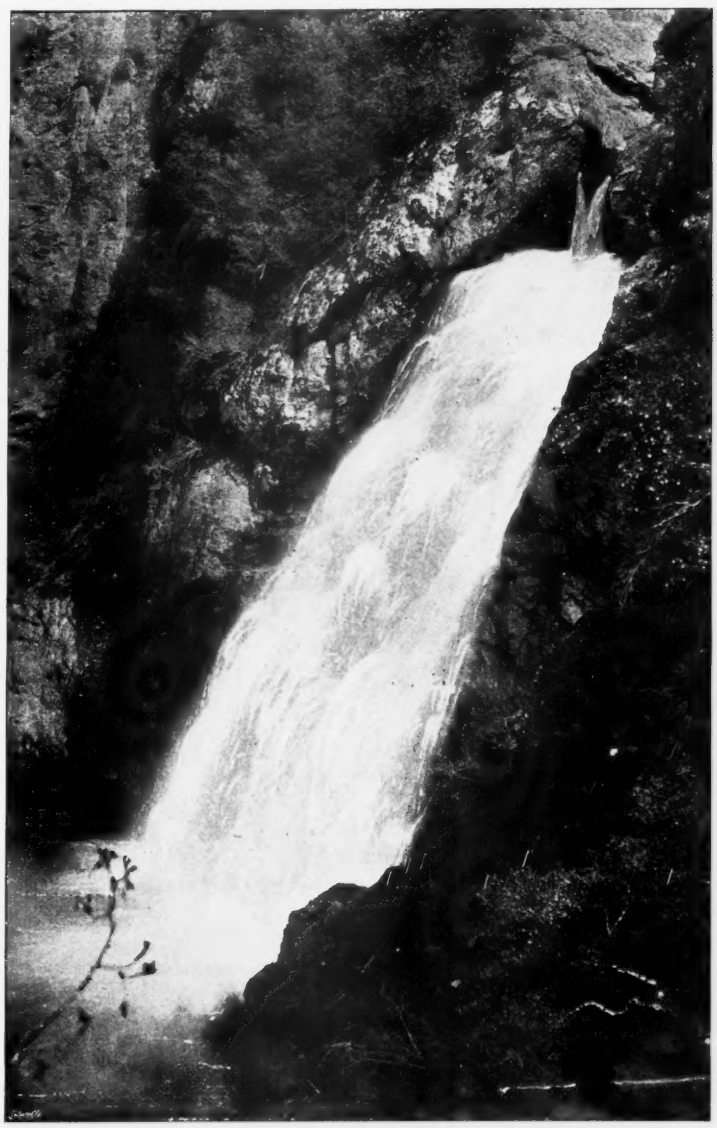
The New Seaport of Bruges.—An Ostend correspondent sends some interesting particulars of the progress of the works for rendering Bruges a seaport. 1,500 men are already employed, the majority being at the little port of Heyst, about 20 miles east of Ostend, from where the great canal to Bruges is to be cut. The work in progress at Heyst is the building of an extensive sea wall and piers and the excavation of docks. It is being carried out by a firm of engineers who have been connected with many large Government works in Belgium. Electricity is utilised for the supply of nearly all the power, including that for the great 250 ton cranes, the brick making machines, &c., as well as for lighting the works. This is the first great application of electricity for power for public works in Belgium, and the result is being watched with great interest. The brick-making machinery is driven by motors, and during this year 18 millions of bricks will be made for the sluice works, some 50,000,000 being required for the whole work. Powerful dredgers are employed deepening the waterway, and in two months the extensive docks, &c., at Heyst will have been excavated. The whole work will cost 40,000,000 francs.

(*Continued on page* 679.)

THE ALUMINIUM WORKS AT FOYERS.

For more than one reason the aluminium works that have been erected on the banks of Loch Ness, some 18 miles from Inverness, and a few hundred yards below the famous Falls of Foyers, have attracted more attention than is usually accorded to an industrial process. It is true that some of the interest aroused has been based on scientific curiosity; but apart from the real and legitimate interest surrounding the production and use of aluminium, much of the attention bestowed upon the proceedings of the British Aluminium Company has arisen from totally different causes.

When it was first proposed to utilise the Falls of Foyers for the purpose of making aluminium, it was imagined by many persons that the beauties of the famous waterfall were to be sacrificed for the convenience of a mere industrial process, and straightway there arose a most vigorous outcry against the machinations of the Aluminium Company. For a time the crusade was carried on in a spirited fashion; public meetings, at which well-known men presided, passed resolutions condemning the alleged vandalism of the aluminium makers; a section of the public press launched a series of invectives against the desecration of scenic beauty, and for a time the Aluminium Company was held up to general opprobrium.



From a photograph by [*D. Whyte, Inverness.*

The Lower Falls of Foyers.

There was, however, much cry and little wool in the utterances of the amiable defenders of our natural scenery, and if they had taken the trouble to make the most superficial inquiries into the schemes of the Aluminium Company, we doubt whether they would have been so ready to deliver judgment upon the proposed operations.

We should not care to define the circumstances that limit the preservation of natural scenery, but while one must appreciate, although, perhaps, not able to entirely agree, with the tenets of Mr. Ruskin and his estimable followers, we think that the sacrifice of scenery for any purpose whatever is always regrettable. It was, therefore, with feelings of gratification that we discovered on a recent visit to Foyers that the beautiful character of the celebrated falls had not been impaired in the slightest degree, and we think that this fact will be clearly established in the course of the following remarks. There is no doubt that, judging from the absence of visitors to the Foyers district, many people have accepted, as a foregone conclusion, that Foyers has been irretrievably spoiled, and though the fact that fewer people than formerly visit the place, does not seriously concern the British Aluminium Company, we think it ought to be clearly set forth that Foyers exists to-day as it is represented in our illustrations. The theory put forward by a noble duke that the fumes from the aluminium works would destroy or seriously affect the trees in the neighbourhood, is best answered by the illustration showing the works from the Pipe Track, which was specially prepared for the purposes of this article. One could not visit Foyers even on business without turning aside to view the well known waterway, and we feel sure our readers will not object to our paying homage to its beauties by giving three pictorial examples. The Upper Falls are a little distance from the first intake, while the Lower Falls are about half a mile nearer Loch Ness. Although the photographs are excellent examples of the photographer's art, having been taken by Mr. D. Whyte, of Inverness, the one of the Lower Falls, owing to the difficulty of selecting a favourable position, fails to give one an idea of the size, though it is clear that the volume of water is considerable. The illustration "A Peep at Loch Ness from above Foyers," which was taken during our visit, gives an excellent idea of the country surrounding the aluminium works.

The development of aluminium is one of the most curious incidents in the history of metallurgy; probably there never was a metal of the baser kind that has been more spoken of and written about than aluminium has during the past few years. Yet, considering how modern is the development of aluminium one has to go back a good many years to discover the first producers of it. It is stated that the first works existing in this country for the manufacture of aluminium was one erected at Battersea by Gerhard, but the owner of the works failed to do more than produce metal at 3s. 9d. per oz. troy, and he abandoned the manufacture some few years later. At a later period the Castner and Cowles processes were started on a large scale, and, for a time, gave every promise of success, but they failed for some reason or other, and practically the only system used nowadays is that due to Heroult and Hall. The method of Heroult has been

used with success at Neuhausen where aluminium has been for some years made on a commercial scale, and is, with some modifications, employed to-day at Foyers.

It is not, however, intended that this article should deal with the various processes that underlie the production of aluminium in all its ramifications. We propose at the moment to deal

From a photograph by [*D. Whyte.*

THE UPPER FALLS OF FOYERS.

mainly with the engineering features that mark the Foyers works. Before doing that, however, we will just call attention to one or two facts in the history and general scheme of operations of the Company. The British Aluminium Company was formed in the year 1894 with a capital of £300,000, for the purpose of producing and working aluminium in this country. In many respects the company's scheme strongly resembled that which had been so successfully carried out at Lauffen-Neuhausen, where one of the large Rhine Falls is utilised for driving turbines of considerable size for the purpose of making aluminium. The experience gained at Neuhausen, both in the design of the plant and the methods employed in working the metal, has been utilised in designing the more recent works at Foyers.

Although the waterfalls in this country are inconsiderable when compared with those on the Continents of Europe and America, it is open to doubt whether those that already exist have not been treated in a somewhat slighting spirit. Of course, for the most part, the waterfalls of any importance in the United Kingdom are far removed from the centres of industry, but we should have thought that it was unnecessary to wait for the advent of commercial aluminium to realise that it was worth while starting an industry, even in somewhat remote districts when there was a prospect of cheap power. Mr. Alph Stieger has already shown in his paper before the Institution of Electrical Engineers that although we cannot hope to rival the Swiss engineers, there are many instances near at hand where water-power is practically available. There is very little doubt that the success of the Foyers works from a power point of view will cause the various falls that do exist to be closely examined. That the British Aluminium Company believe in water power is obvious from the fact that they have already secured extensive water rights in Wales, and when these are properly developed, they will be to a great extent utilised by the Acetylene Illuminating Company in the manufacture of calcium carbide.

The most distinguishing feature at Foyers is undoubtedly the use of a water-power of small volume, but having a specially high fall, and when we say that the fall at Foyers is one of 350 feet, while that at Neuhausen is 65 feet, and at Niagara 120 feet, some idea may be gained of the nature of the power that is available at Foyers. On referring to the plan and section of the undertaking, it will be seen that water is taken from the River Foyers, some three-quarters of a mile above the factory, at a point where the river bends, and flows down the rapids into the Upper Falls. A large body of water collects at the bend in a naturally formed basin, and from thence passes into the first intake, where it flows through a tunnel half a mile in length, until it arrives at the Penstock Chamber, where it passes down six lines of pipes to the turbines. On reference to the section of the scheme it will be seen that the tunnel is to all intents and purposes straight, there not being more than a foot drop from one end to the other, the great fall of water being obtained in the pipes, between the last penstock chamber and the factory.

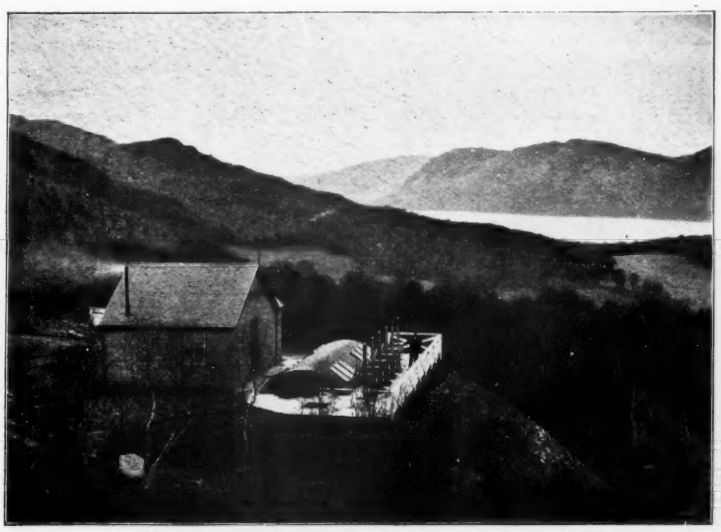
The water in the River Foyers is practically the drainage from 100 square miles of land, and naturally the amount of water in the river varies with the season. It may be, however, of some significance to the tourist to know that there have been one or two occasions when though water could not be obtained for the turbines, a moderate quantity was passing over the Falls. The operations upon which the company are engaged at the present moment are intended to keep the quantity of water in the River Foyers practically constant, and this very desirable condition is to be achieved by raising the level of two lochs on one of the upper plateaus, and making of these two one grand loch $5\frac{3}{4}$ miles long by $\frac{3}{4}$ of a mile wide. When this is completed the water storage will be equivalent to 3,600,000,000 gallons, which is, we believe, in excess of the capacity of most of the reservoirs connected with the water supply of large towns.

From a photograph by [*D. Whyte.*

VIEW OF THE FACTORY FROM THE PIPE TRACK.

The constructive work at Foyers was commenced in the month of July, 1895, and the initial operation was the making of the tunnel; the making of the weirs, cutting the trenches and building the factory were commenced shortly afterwards, and then most of the different operations were carried on simultaneously.

As we have already said, there is a deep pool outside the first intake, and from this the water passes into the intake, two views of which are given. This intake has been excavated out of the solid rock, and is about 20 feet deep. It will be seen that the intake is in two portions which are connected together by a short length of tunnel. In connection with this section of the work we have prepared an interesting illustration, which shows the workmen making preparations for the final blast at the end wall of the intake preparatory to the large body of water coming through. It will be seen that while the men are working, water is trickling through in moderate quantities, the tarpaulins and other temporary expedients alone preventing the inrush of water. Another view shows a portion of the intake as well as the first penstock chamber, where the water enters the tunnel. The penstock is of circular shape, and the entry of water is controlled by five metal gates. The valves of the penstock are of the usual type, and the position of the gate is shown by a pointer immediately above the hand wheel. The man in charge of the penstock lives close by, and is in telephonic communication with the works. In order, however, to guard against the effect of a sudden increase of water in the tunnel, an electrical contrivance is used, which gives the alarm when the water exceeds a certain height. It consists practically of an aluminium float, which carries contacts at its upper end, and when the water reaches a certain predetermined height closes an electrical circuit and causes a bell to ring, which continues to ring until the sluices are properly regulated.



From a photograph by *Whyte.*

VIEW OF MAIN PENSTOCK CHAMBER.

From a photograph by *[D. Whyte, Inverness.*

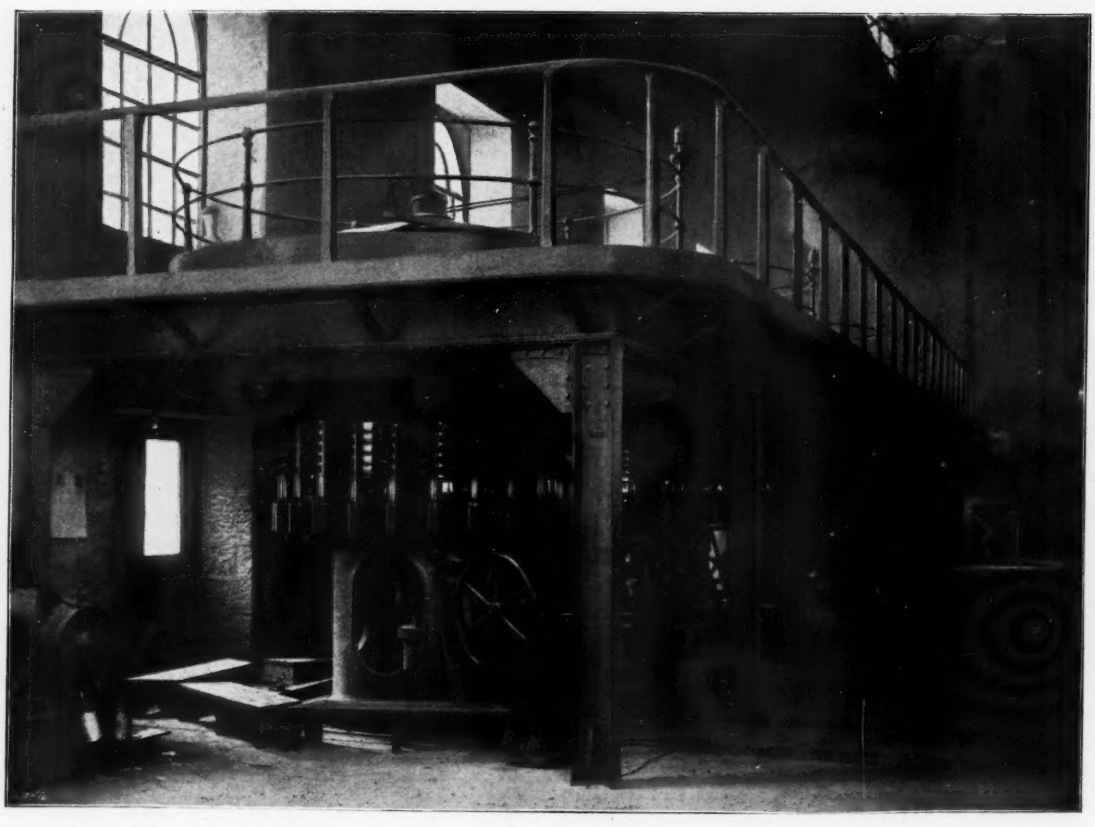
VIEW OF INTAKE AND FIRST PENSTOCK.

The tunnel, as we have already said, is about half a mile in length and has been bored through the solid rock, which for the most part consists of hard limestone. The diameter of the tunnel is 8 feet 6 inches, and a good idea of the nature of the work entailed may be gathered from the illustration, which shows the tunnel in course of construction. The interior is throughout ⅞ths of its length faced with cement, and in only one instance has it been necessary to shore up the tunnel. Owing to the nature of the rock the thickness of cement is in some cases very considerable, the layer of cement at some points being 6 feet thick. The tunnel was bored through from eight vertical headings, which, working both ways, gave 16 different points at which the tunnel was worked; taking the fact into consideration that there is only a drop of 1 foot from one end of the tunnel to the other, the boring from 16 points must have been done with considerable accuracy. The tunnel headings are provided with clearing out valves, while at some are relief weirs which would relieve the pressure of water, if it were necessary at any time. It is obvious that in building so important a piece of work as the tunnel it would be designed to convey water to meet increased demands for power that might arise; and, as a matter of fact, the size of the tunnel would be large enough to meet all future requirements.

The position of the main penstock house will be seen from the illustration. It is at the junction of the tunnel and the pipe lines which lead direct to the turbines, the pipes being laid down the slope of the hill. The penstock chamber is constructed of granite, and lined throughout with concrete. There are five large pipes which convey the water to the turbines for reduction purposes, and one small pipe which is used exclusively for driving the lighting machinery. The diameter of the large pipes at the penstock end is 30 inches, but reducing pipes are inserted at two different points. A very clear idea of the method of controlling the flow of water into the pipes will be obtained from the two views showing the valves of the penstock chamber. It will be understood that these views show the penstock chamber at a very early period in its construction, and they are interesting as showing some of the details of the valves, back and front. The control of the water is simply effected by an iron door, which closes over the mouth of the pipe. Besides the doors, however, which are operated by hand wheels in the usual way,

From a photograph by] [*D. Whyte.*

VIEW OF FIRST INTAKE AND PENSTOCK.



From a photograph by] [*D. Whyte.*

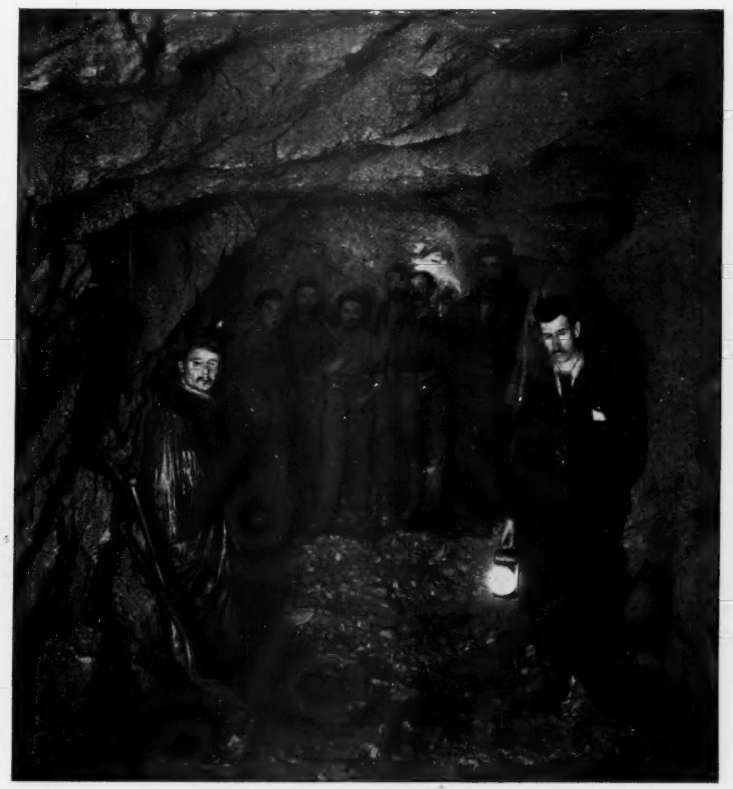
VIEW OF THE GENERATING MACHINERY.

emergency doors are provided, and these drop into position upon knocking out an iron peg. At the extreme end of the pipes the water can be further controlled by means of sluice valves, which are placed near the machines. The turbines are of the impulse type, with partial injection, and drive the dynamos by means of vertical shafts. At the present moment there are five combined sets in position, though three more are to be erected this year. Each turbine is designed to develop 700 brake horse-power with a 350 feet fall, when running at 140 revolutions per minute. The diameter of the turbines from one side of the vanes to the other is slightly over 10 feet; the vertical shaft, already alluded to, carries a series of arms, on the end of which the vanes are built in the form of a ring. The shaft is of steel, is 8 inches in diameter, and runs in a step bearing; on its upper end the armature is built, and as this weighs some 14 tons, it is obvious that careful adjustment is necessary. From the illustrations of the dynamos in course of construction, and the view of the finished machines, an idea will be gained of the general arrangement. The turbines have been constructed by Escher, Wyss and Co., of Zurich, and the dynamos supplied by the Maschienenfabrik Oerlikon. The magnet frames are built up of soft cast iron, and are supported by iron columns. There are 24 poles on each machine, and the coils are arranged to be easily replaced. As we have already said, the armature weighs 14 tons, and is 8 feet in diameter. During our recent visit to Foyers one of the armatures was being overhauled, and we took advantage of the opportunity and had it photographed. The core of the armature is built up of soft-iron castings, and the winding is on the method known as the multipolar drum winding. The commutator, which is 6 feet in diameter, has 216 segments. Another distinguishing feature in the machine is that 120 brushes are employed, which are carried on heavy brush holders, which in turn are supported on two large copper rings. Current is led away from the dynamos to the furnaces for a short distance by means of heavy copper strips, which are connected to ordinary cables.

Details of Valves in Penstock Chamber, Photographed during Construction.

The water, when it has passed through the turbine pits, runs off in large iron pipes underneath the factory to the tail race which flows into Loch Ness.

There is very little in the power-house to notice beyond that already mentioned, except the lighting plant, which consists of a small lighting dynamo driven by a Pelton wheel. At the present moment practically four dynamos are being used for aluminium purposes, while the fifth is being utilised for the production of calcium carbide, which is being carried on in a temporary way by the Acetylene Illuminating Company. We have already said that it is not proposed to say much in this article regarding the production of aluminium, but we ought to mention the provision that has been made to deal with the raw and the finished material. One of the views shows the wharf where the alumina is landed, and from whence the ingot aluminium is shipped to the other factories of the company. At Foyers nothing beyond reducing the alumina to aluminium is done; raw material is simply provided, and this is worked into a commercial condition at the mills in Staffordshire. It is obvious that the operations of the company are scattered; the Glenravel mines produce the bauxite, Larnes works it up into alumina, which is sent in the form of fine flour in steel casks to Foyers, and from thence raw aluminium is sent to Milton. In addition there is a factory at Greenock, which is occupied solely with the production of carbon, a commodity which it is hardly necessary to say forms an important part of an aluminium furnace. The Greenock works, however, in addition to producing carbon for the company's own use, will shortly be able to meet the large outside demand for electrolytic carbon that exists at the moment.



Tunnelling Operations.

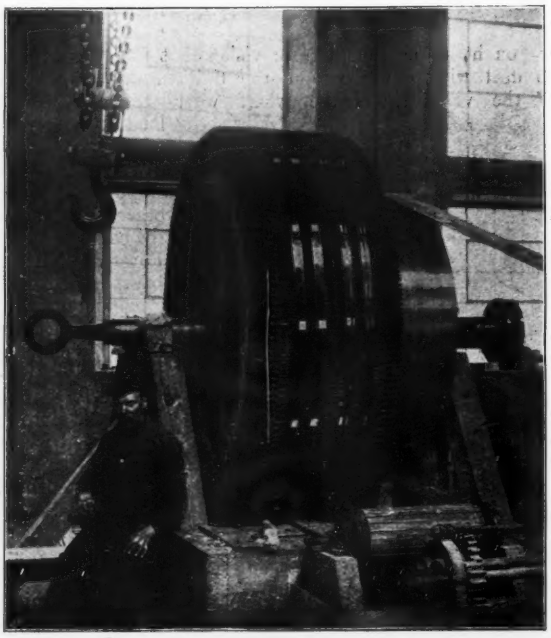
Although the fact scarcely comes within the scope of this article, it is perhaps worth recording that the British Aluminium Company has already achieved a striking industrial success. It has succeeded, despite its comparative youth, and the fact that the factory has been working scarcely 12 months in making profits which are large enough to show that the demand for aluminium is a real one. Mr. Roger Wallace, the chairman of the company, at the last meeting said that the demand for aluminium was increasing at a very rapid rate, and his fear was, that unless they made immediate provisions they would be unable to cope with it.

We are indebted to Mr. E. Ristori, the managing director, and to Mr. W. Murray Morrison, the engineer in charge of the works at Foyers, for the foregoing details, as well as for the loan of some of the photographs.

TRACTION BY ACCUMULATORS.

The *Elektrotechnische Anzeiger* publishes an article describing some experiments made with a tramcar propelled by accumulators, from which we (M. F. Feer in *L'Industrie Electrique*), give the following extract, which is completed by some results obtained during regular service:—

The experiments were made on a track closed upon itself,



From a photograph by [*D. Whyte.*

Foyers: One of the Armatures.

335 metres in length, 181 metres being round curves with radii of 50, 30, 25, and 15 metres, 154 metres being in a straight line. In this last section was an incline of 2 in 100 over a length of 54 metres, and a short incline of 5 in 100. The car used weighed 6·5 tons. The battery of accumulators of 2·9 tons consisted of 84 elements in lead boxes with 40 amperes of normal discharge current. Total weight of the car when empty = 9·4 tons.

The various experiments may be summed up as follows:—*Car empty*, 9·4 tons. *Uninterrupted journey*, 240 watt-hours per kilometre at a speed of 18 km. per hour; 26 to 30 amperes at 162 volts on an average; 716 watt-hours per kilometre at a speed of 14 kilometres an hour on an ascent of 2 in 100; 56 to 60 amperes at 162 volts on an average. The battery charge is sufficient for a journey of 80 km.

Car empty, 9·4 tons. *Journey broken*, three times per kilometre; quick stoppage of the car on an ascent of 2 in 100; 340 watt-hours per km. at a speed of 12·6 km. an hour.

The battery charge is sufficient for a journey of about 60 kilometres.

Car with passengers (from 30 to 40 persons), 11·9 tons. *Uninterrupted journey*, 340 watt-hours per kilometre. *Journey with interruptions*, three times per km. on the in-

Foyers: Constructing one of the Dynamos.

cline of 2 in 100; 550 watt-hours per km. at a speed of 11 km. an hour.

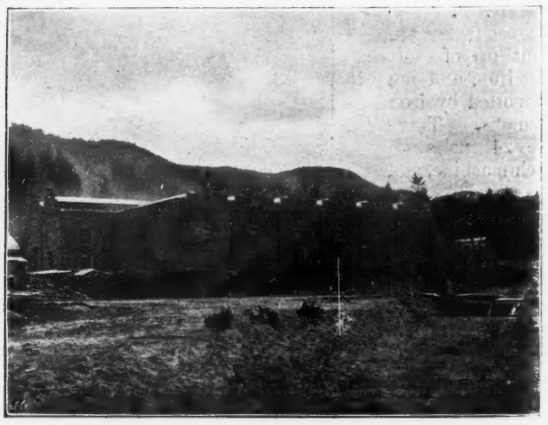
The battery charge is sufficient for a journey of about 48 km.

The starting on the incline and in the curve with 15 metres radius took a very strong current, from four to five times the normal current of 40 amperes.

Energy used by the Dynamo for charging the Battery.—*Car empty:* 9·4 tons. *Uninterrupted journey:* 380 watt-hours per km.

Journey with interruptions.—Three times per kilometre on the incline of 2 in 100; 500 watt-hours per km. *Car loaded:* 11·9 tons. *Journey with interruptions:* Three times per km. on the incline of 2 in 100; 680 watt-hours per km.

We may observe that these results may be considered as maximum values of the regular service of a tramway. Few systems are laid under such unfavourable conditions as the



From a photograph by [*D. Whyte.*

The Foyers Factory from the Banks of Loch Ness.

trial line, both as regards curves and inclines, and also the state of the track. By substituting ebonite for lead in the boxes, and also by employing a lighter car, the total weight of the car might be reduced by about a ton. In order to compare the energy expended for traction by accumulators with that required for traction by overhead conductors, we must take into account the following considerations:—

The central stations for traction by overhead conductors require about double the power of those intended for traction by accumulators, both having the same number of cars

in circulation simultaneously. For the first of these systems the variations in the intensity of the current at the central station amount to 100 per cent., so that the installation

From a photograph by [*D. Whyte.*

FOYERS: VIEW OF THE WHARF ON LOCH NESS.

works under very bad conditions. It is true that these variations can be annulled by using a battery of accumulators working in parallel with the dynamos, as is done, for instance, in the case of the Zurich tramways. But in both cases the efficiency of the station is bad, and the capital required for first establishment high. On the other hand a battery of accumulators increases the weight of the car by from 45 to 50 per cent. The energy to be used for the journey is therefore increased by about 50 per cent. But the quotient of the dead weight by the total weight diminishes as the car fills up, so that when once it contains its complement of 30 to 40 passengers, the 45 to 50 per cent. is reduced to 30 to 35 per cent.

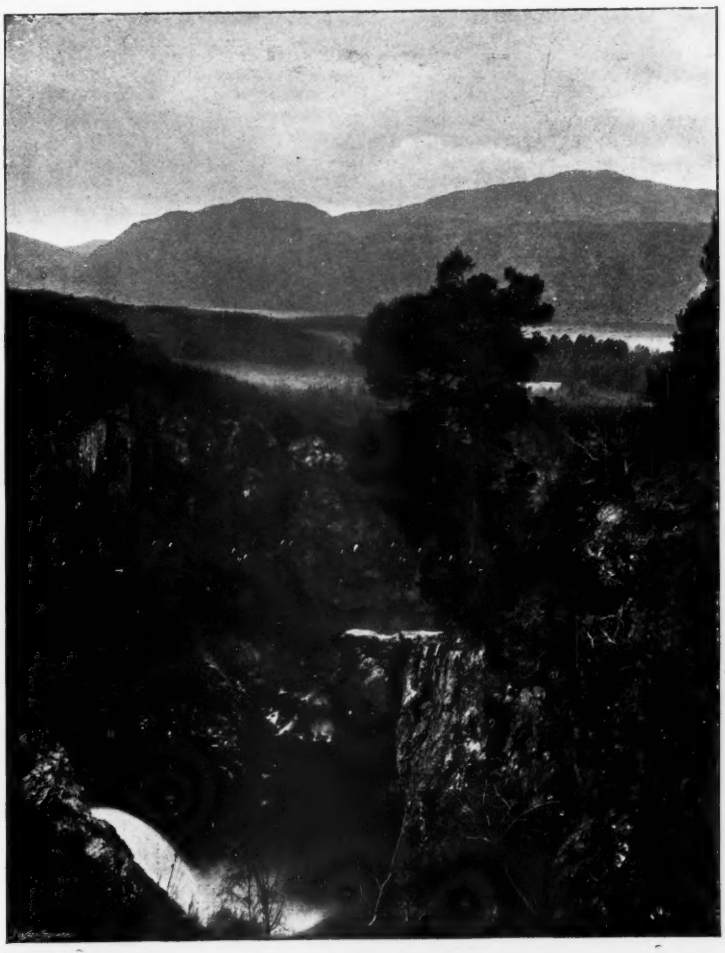
Assuming for the accumulators an efficiency of only 75 per cent., the energy used for the motor is, at the most, double that used for the motor of a car worked by overhead conductors.

According to the results obtained:—

1 kg. of coal produces from 600 to 650 watt-hours at the terminals of a dynamo used to charge the accumulators.

1 kg. of coal produces only 425 watt-hours, if the dynamo is working on an overhead system (Hanoverian tramways).

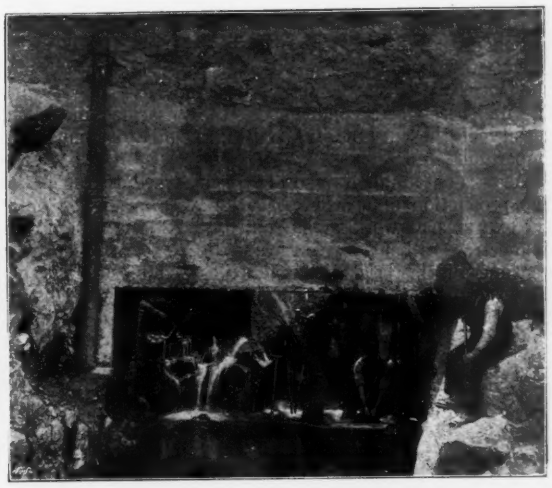
For this last system a car kilometre uses from 420 to 440 watt-hours.



From a photograph by [*D. Whyte.*

A PEEP AT LOCH NESS FROM ABOVE FOYERS.

We have just seen that with an accumulator car we use 680 watt-hours per car kilometre, and that under very un-



FOYERS: PREPARING FOR THE FINAL BLASTING OPERATIONS BEFORE WATER ENTERS THE INTAKE.

favourable conditions. The expenditure of coal is therefore almost equal in the two systems. All this is confirmed by the results furnished by the Hanoverian tramways.

At Hanover the cars were all worked by overhead wires, and without accumulators up to September, 1895. Since that time, two-thirds of the cars have been provided with batteries, which are charged by the overhead system, and which, in certain parts of the town, work the car.

For traction by overhead conductors, without accumulators, 438 watt-hours were used, on an average, per car kilometre. After the changes above mentioned (mixed system), the central station expended 605 watt-hours per car kilometre. These figures are much less than those given for unfavourable conditions. Only we must not forget that it is only two-thirds of all the cars on the electrical distribution system that carry a battery.

The annual cost per car kilometre for working with accumulators is only 1·25 centimes higher than for working without accumulators. This advantageous result for working with accumulators would be appreciably increased if all the cars had batteries, and if these latter were charged from the central station.

The expenditure of coal was:—

In August, 1895, 1·18 kg. per car kilometre, or for 438 watt-hours.

In August, 1896, 1·2 kg. per car kilometre, or for 605 watt-hours.

Only for purposes of comparison we must take into account the fact that the central station of Hanover is not yet working under the best conditions, as the variations in the intensity of the current still exist, although to a much less important extent.

As a rule, too much importance is attached to the cost of the production of energy. At Hanover, for eight months, the expenses of working amounted to 22 centimes per car kilometre (without sinking fund and interest), only 1·6 centimes of this being for coal. These figures do not show the exact proportions, for the Hanoverian tramways have a system of 78·7 kilometres, 27·2 of which are worked by horses.

Cost of Installation.—According to M. Uppenborn, the cost per kilometre of overhead tramway system is, on an average, for a single line, 18,500 fr., for a double line, 27,000 fr.

A battery of accumulators for a car costs 3,750 fr. We can, therefore, with the same capital provide for every kilometre of overhead wires five batteries of accumulators for a single line, and seven batteries for a double line.

Maintenance, Sinking Fund, Interest.—Overhead system, single line:

	Per cent.
Maintenance and superintendence per kilometre per year	5 of 18,500 fr.
Interest assumed	6
Sinking fund	3
	13 % of 18,500 fr. = 2,405 fr.

Overhead system, double line:

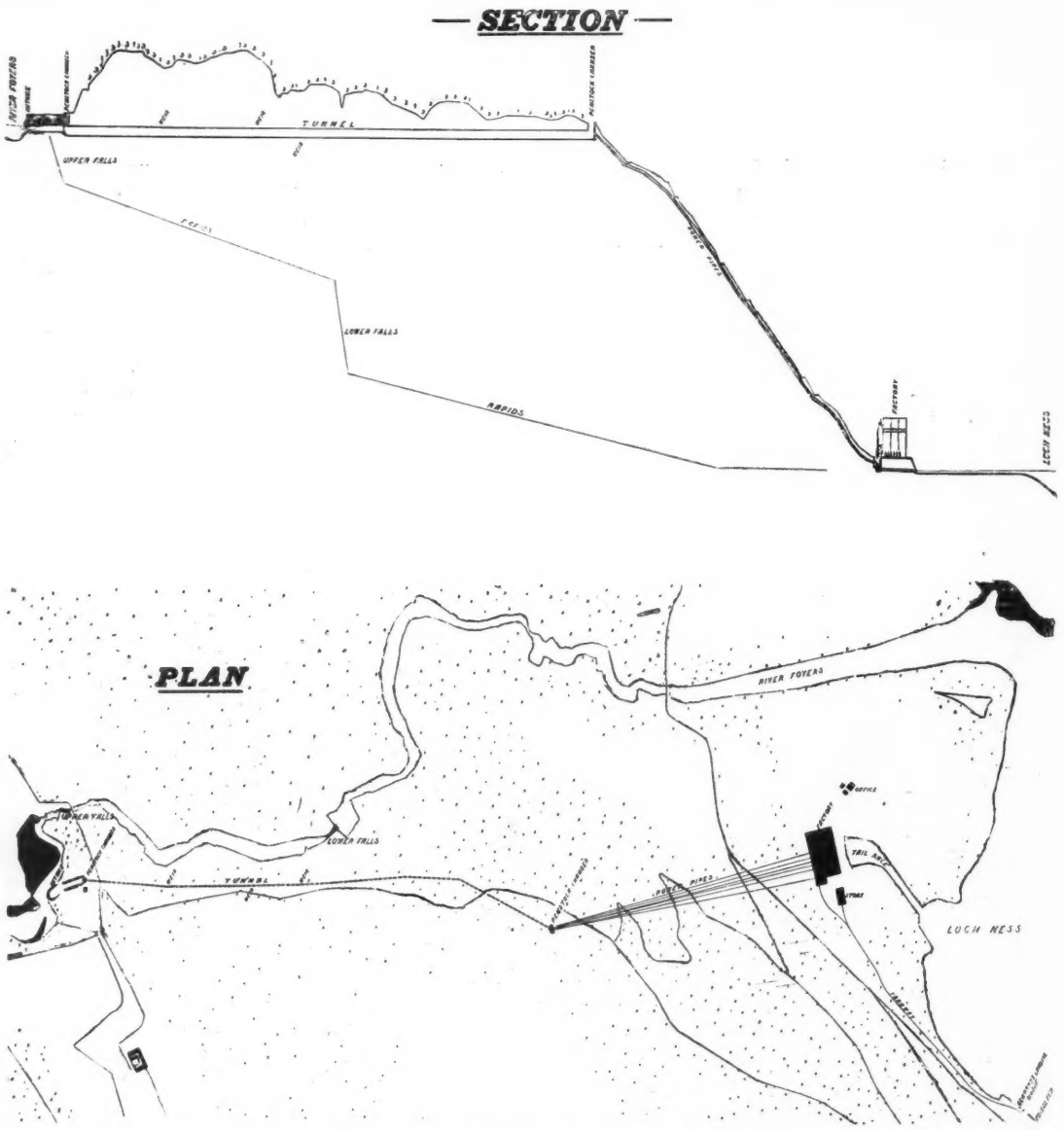
As above	13 % of 27,000 fr. = 3,500 fr.
Accumulators—Maximum maintenance per car per year ...	1,250 fr. = 30 % of 3,750 fr.
Interest, sinking fund— 5 + 3 = 8 %	300 fr.
	1,500 fr.

It is, therefore, possible to work simultaneously with the same cost of maintenance, sinking fund and interest, on 1 kilometre of single line with overhead conductors:—

1·6 accumulator cars, or ·8 car each way.

1 km. of double line with overhead conductor; 2·25 accumulator cars or 1·13 cars each way.

Assuming a speed of 12 km. an hour, the circulation of accumulator cars can be effected for a single line installation at intervals of 6·52 minutes between each car going the same way, and for a double line installation at intervals of 4·5 minutes.



FOYERS: PLAN AND SECTION OF WATER POWER SYSTEM.

As the receipts increase, the distances between two consecutive accumulator cars can be still further reduced without the above-mentioned expenses exceeding the line expenses with the overhead system.

Conclusions.—The principal conclusions to be drawn from these results are:—

Traction by accumulators can very well be carried on simultaneously with traction by overhead conductors.

The working of a tramway by accumulators is the more advantageous in proportion as:

(*a*) The intervals between two consecutive cars are longer;

(*b*) The interruptions in the journey are fewer.

The working of a tramway by accumulators is no longer advantageous when the journey includes long ascents of more than 2 or 3 in 100.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 670.)

The London Tramways.—At Tuesday's meeting of the London County Council the Highways Committee submitted a long report stating in detail the result of the arbitration proceedings in respect to the purchase of the depôts and other buildings belonging to the North Metropolitan Tramways Company and to the London Street Tramways Company. The amount of the award was £173,186. This sum was £46,129 more than the estimate of the Council's valuer of the constructional value, and £48,614 more than his estimated value of the buildings, &c.; it was less by £128,261 than Sir J. Whittaker Ellis's estimate, and £133,291 more than that of Mr. Bousfield. The fee charged by the arbitrator was £983 17s. 6d., which the Committee thought was a large amount. The Council, however, will only pay half of the cost of the award. The result of the decision of the arbitrators was that the estimate of £675,000 already approved by the Finance Committee would need to be supplemented by £30,000. The consideration of the report was postponed by the Council's standing orders until next week. The Islington Vestry has given the Clerk authority to oppose the North Metropolitan Tramways Bill, which recently passed its second reading.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Hong Kong-Macao	May 3rd, 1897 ...	May 10th, 1897.
Konakry-Sierra Leone ...	April 28th, 1897 ...	...
Para-Maranham	May 5th, 1897 ...	...
Perim-Assab	May 9th, 1897 ...	May 11th, 1897.
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Moulmein-Bangkok	May 5th, 1897 ...	...
Saigon-Bangkok	May 8th, 1897 ...	May 9th, 1897.

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *viâ* Bosnia, Montenegro and Servia.

The Ottoman Government announce that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be in plain language.

April 21st, 1897.—Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 10th, 1897.—From July 1st next the Japanese office has fixed a uniform terminal rate of 70 centimes.

American Telephone Litigation.—The New York correspondent of the *Financial Times* says that on Monday the Supreme Court pronounced judgment in the case of the United States Government against the American Bell Telephone Company, the verdict being in favour of the defendants on all points. The chief argument of the plaintiff attorneys for the repeal of the Berliner transmitter patent was based on the ground that the defendants had been guilty of fraud in the Patent Office in holding back their application from 1877 to 1891, thus obtaining a monopoly for 32 years—the grant in respect of the Berliner invention extending till 1909. It was contended that the original Bell patent of 1876 really covered the invention for which fresh protection was secured in 1891. "The decision now given prolongs the monopoly for a dozen years, and will probably lead to an increase of competition with the Western Union Telegraph Company. The old working contract between the two undertakings expired, it will be remembered, in November last and was not renewed."

Cable Communication with Australia.—Some of our readers may know that, owing to the interruption of both the Eastern Company's cables to Alexandria during the latter part of March, some delay arose in the transmission of telegrams. From journals recently to hand from New South Wales, we make extracts showing the inconvenience caused in that colony. These extracts bear dates March 25th, 26th, 29th, and 30th respectively:—

The Port Darwin Line.—We are informed by the Electric Telegraph Department that the telegraphic business on the Port Darwin line was delayed last night owing to the line working badly. We are consequently without our usual cable news this morning.

The Cable Service.—In reference to the delay which has taken place in the transmission of cable messages, we are informed by the Electric Telegraph Department that the Postmaster-General has been advised as follows:—"The cables between Malta and Alexandria are interrupted. There is great pressure in the traffic on the Indo-European lines, and it is possible that there will be delay in both directions." Karachi also reports:—"Block here; still forwarding yesterday's work to Europe."

Broken Cables.—The Postmaster-General has received the following:—"Madras advises that the cables are broken close to Alexandria. The sea is very rough, but is going down. Attempts to repair the cable are to be made to-day, the 26th."

The Cables Restored.—The Postmaster-General has received the following:—"March 29th. Singapore advises that the Malta and Alexandria cables were restored last night. Traffic is now passing as usual."

From a Western Australian journal, dated March 27th, we extract the following:—"During yesterday a few additional cable messages from London came through, which we publish this morning. Our cable dates are still, however, two days in arrear."

French Activity in the West Indies.—The Curacao-Coro cable was opened to the public for international service on the 7th inst. This is the first office of the proposed system of communications to be laid by the French along the Venezuelan coast.

London-Paris Telephones.—The telegraph ship *Monarch* on Saturday last laid the second telephone cable for the London and Paris service. The new cable is 24 miles in length, contains two separate metallic circuits, and is of the same type as the first cable. The French end was landed at Sahout, four miles west of Calais, the English end being at Abbot's Cliff, three miles west of Dover. A third cable is to be laid by the French Government, and is now being constructed.

The Hawaiian Cable.—It is stated that Mr. Spalding, of New York, has withdrawn from his contract with Hawaii for the construction of a cable to the American coast, having failed to secure the expected assistance from the United States.

Telegraphic Communication with South Africa.—It is intended, says the *Daily Mail*, to press upon the attention of the Government and of the Eastern Telegraph Company the necessity, in view of possible war contingencies in South Africa, of laying an all-British cable from Zanzibar to Durban. Our contemporary hears that, in the event of the representations which may be made to the Eastern Telegraph Company not being entertained by them, a separate company will probably be formed to lay a Zanzibar-Durban line.

The Telegraph Wire Export Trade.—Though there was nothing like the activity prevailing as was recorded in March last, the export trade in telegraph wire and apparatus connected therewith during April last was on the whole fairly satisfactory, the exports for the month having amounted to £75,688 as compared with £23,066 in the corresponding month of last year and £35,544 in April, 1895. Taking the year so far as it has gone, a much more satisfactory state of affairs is prevailing than has been recorded for some years, the total value of the exports during the four months ending with April last being returned at £321,160 as compared with only £211,368 in the corresponding period of last year.

Underground Wires in the City.—In the House of Commons last week Mr. Hanbury, questioned by Mr. Lough as to disagreement between the Post Office and the Commissioners of Sewers on the question of telegraph wires in the City, and the great inconvenience to private persons and firms who were unable to get wires laid, said: The Postmaster-General is aware that inconvenience is being caused to private persons and firms by the refusal of the Commissioners of Sewers to give consent to open the ground for the provision or transference of wires to their premises. Powers had been conferred by Parliament on the Postmaster-General to carry out works of this kind, subject to the consent of the authorities controlling the streets, and he has a right of appeal to a legal tribunal, and in the final result to the Railway Commissioners against the refusal of consent. The Postmaster-General is now considering what steps he should take in the public interest; but he trusts he will not be compelled to resort to appeal. The Commissioners of Sewers have in the past done what they could to facilitate the operations of the Post Office, and have shown the Department every courtesy. Replying to further questions by Mr. A. Gibbs and Mr. Lough as to telephone as well as telegraph wires, Mr. Hanbury added that if two sets of wires were to be laid, it was to the advantge of the local authority that they should be laid at the same time.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bedford.—June 8th. The Urban Sanitary Authority want tenders for the supply and erection at the sewage pumping works of two alternating current motors coupled direct to two vertical spindle centrifugal pumps. See our "Official Notices" for particulars.

Belfast.—June 3rd. The Electric Committee want tenders for the supply and erection of switchboard, instruments and connections, also a motor-generator and boosters. See our "Official Notices" for particulars.

Brazil.—June 30th. Tenders are being invited until June 30th next by the Municipal Authorities of Rio de Janeiro for the establishment of a telephone exchange in the city. Particulars of the contract were published in *Daily Tenders and Contracts* for May 6th.

Chili.—June 19th. The General Direction of the Chilian Telegraphs in Santiago is inviting tenders for the supply of a quantity of galvanised iron wire, insulators, Morse telegraph apparatus, &c.

Dingwall.—May 22nd. The Burgh Council is prepared to consider proposals from persons or companies willing to undertake the free electric lighting of this town. Particulars from Mr. A. Hill, Hillhouse, Dingwall, the Council's electrical engineer.

France.—May 20th. Tenders are being invited by the General Direction of the French Post and Telegraphs in Paris for the supply of 21½ kilometres of paper-insulated telegraph cable. Tenders to the Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—May 25th. The General Direction of the French Post and Telegraphs in Paris is inviting tenders for the supply of a quantity of telegraph and telephonic apparatus. Tenders to the Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Germany.—The Municipal Authorities of Münstereifel are at present inviting tenders for the erection of a central electric lighting station, with the object of utilising certain available water power in the district. No definite date has been fixed for the final receipt of tenders, but particulars may be obtained from Das Burgermeisteramt, Münstereifel.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Spain.—June 8th. The Spanish Ministry of Public Works in Madrid is inviting tenders for the concession for a projected electric tramway between Barcelona and its suburbs. Tenders to the Direccion Generale des Obras Publicas, Madrid.

Sunderland.—May 26th. The Corporation is prepared to receive tenders for a high-speed three-crank steam dynamo. Particulars from Mr. J. F. C. Snell, the Borough Electrical Engineer.

Wakefield.—June 2nd. The Wakefield Board of Guardians want tenders for the following work for the new infirmary:—1. Electric lighting plant, combined steam engine and dynamo, belt-driven dynamo, motor dynamo, motor, switchboards, storage cells, &c.; 2 Complete system of wiring for the electric light, also bells and telephones; 3. Vertical steam engine, feed water heater, tank, pumps and pipe work, &c. Particulars from Messrs. Shepherd & Watney, engineers, 71, Albion Street, Leeds.

CLOSED.

Aberdeen.—*Daily Tenders* gives the following list of tenders sent in for the supply of battery regulating switches:—

	£	s.	d.
Edison & Swan Co., Ltd.	117	0	0
Crompton & Co.	90	0	0
Alex. Spark	87	14	0
D. P. Battery Co.	66	10	0
Stephens, Smith & Co.	56	0	0
Williamson & Joseph (accepted)	50	0	0
Ernest F. Moy, Ltd.	48	0	0
Veritys, Ltd.	27	10	0

For the supply and erection of 125 accumulator cells, having a capacity of 400 ampere hours:—

	£	s.	d.
Epstein Accumulator Co.	835	12	0
G. R. Blot	722	0	0
Chloride Electrical Storage Syndicate	714	0	0
A. B. Pescatore	660	0	0
I.E.S. Accumulator Co.	646	5	0
E.P.S. Co.	620	0	0
E.P.S. Co. (alternative offer)	700	0	0
Pritchetts & Gold	601	0	0
D. P. Battery Co.	566	15	0
Allen & Adamson, Ltd.	508	0	0

The prices quoted for maintenance were as follows, the prices being for 2nd, 3rd, 4th, and 5th year respectively:—

	£	s.	£	s.	£	s.	£	s.
Epstein Co.	29	3	37	10	45	16	54	3
Blot	36	2	36	2	36	2	36	2
Chloride Syndicate	35	0	37	0	40	0	42	0
Pescatore	48	0	48	0	48	0	48	0
I.E.S. Co.	32	6	49	6	64	12	79	15
E.P.S. Co.	50	0	50	0	50	0	50	0
Ditto	80	0	80	0	80	0	80	0
Pritchetts & Gold	18	0	27	0	30	0	45	0
Allan & Adamson	50	0	50	0	50	0	50	0

Mr. A. Blackman is the borough electrical engineer.

Bath.—For the supply of two electroliers in the new pump room, nine tenders were sent in ranging from £300 to £146, and that of Messrs. Veritys, Limited (the lowest) is recommended for acceptance.

Bedford.—We understand that the contract for two water tube boilers with mechanical stokers and other apparatus, has been given to Messrs. Babcock & Wilcox at £1,415, which was the lowest tender.

Brighton.—The Lighting Committee have accepted the tender of Messrs. Babcock & Wilcox to supply and fix steam pipes, &c., for the new boilers for the Corporation Electricity Works, for the sum of £570.

Colchester.—The Town Council have resolved to accept the tender of Messrs. G. Grimwood & Sons, of Sudbury, for the erection of their electric lighting station buildings, the quotation being £2,996. The other quotations were:—Mr. W. Chambers, £3,775; Mr. A. Diss, £3,740; Mr. F. Dupont, £3,690; Messrs. Dobson & Son, £3,689; Messrs. H. Everett & Son, £3,594.

Islington.—The Vestry is stated to have accepted the tender of Messrs. Crompton & Company, Limited, for a Brotherhood steam engine, and an alternator and dynamo of the Crompton type.

Kensington.—The Vestry has accepted the tender of Messrs. C. J. Grist & Company, for the construction of private telephone wires, and supply of certain instruments for connecting the Vestry's depôts with the Town Hall Building by telephone, for the sum of £135.

Reading.—The contract for Reading extension for electric light cables and mains recently advertised for, has been given to the Fowler-Waring Cables Company, Limited. The approximate value is £1,540.

NOTES.

Liquid Air.—Lecturing at the Royal Institution last week on the subject "Liquid Air as an Agent of Research," Prof. Dewar continued his remarks commenced at his first lecture, on the critical constants of gases, and brought forward some interesting speculations founded on the extension of certain laws, known by experiment to hold good at accessible temperatures, to bodies which one could never hope to be able to examine in the liquid state. With regard to the theory that carbon is a very important constituent of the sun, he pointed out, says the *Times*, that the density of the latter was 1·4. Supposing it to consist of carbon at the critical temperature, its density when cooled to liquefaction would become 4·2, according to known laws, and if it were cooled to the temperature of this earth its density would increase by something like one quarter. Therefore the density of the materials of the earth (which was 5·5) did not appear to be far removed from the density of the sun at the same temperature. The rest of the lecture was mainly occupied with experiments illustrating the capacity of high vacua to retard the passage of heat. In conclusion the lecturer, for the first time in public, froze a specimen of argon, supplied by Lord Rayleigh, to the solid state by means of liquid air at a temperature more than 200 deg. below zero.

Falcon Works Engineering Society Annual Dinner.—The Falcon Works Engineering Society held their annual dinner on Friday last, 7th inst., at the Bull's Head Hotel, Loughborough, Mr. J. S. Raworth presiding. Over 50 gentlemen sat down, and a most enjoyable evening was spent. Several speeches were made during the evening, interspersed with excellent songs. Amongst those present were:—Messrs. Stephen Sellon, F. C. Esmond, V. B. Cooper, A. E. Rossiter, C. H. Rome, F. Leigh and W. Bolton, besides most of the leading members of the Brush Company's staff, including Messrs. R. Percy Sellon, W. M. Mordey, G. C. Sillar, C. E. Hodgkin, F. E. Andrews and A. G. Hansard.

The Royal Society.—The following papers were down for reading yesterday afternoon:—Prof. Ramsay, F.R.S., and M. W. Travers: "An Attempt to cause Helium or Argon to pass through Red-hot Palladium, Platinum, or Iron." Shelford Bidwell, F.R.S.: "On the Negative After-Images following Brief Retinal Excitation." Dr. J. Larmor, F.R.S.: "A Dynamical Theory of the Electric and Luminiferous Medium. Part III., Relations with Material Media." E. B. H. Wade: "On a New Method of Determining the Vapour Pressures of Solutions." T. E. Stanton: "On the Passage of Heat between Metal Surfaces and Liquids in Contact with them." H. Wilde, F.R.S.: "On the Magnetisation Limit of Wrought-Iron."

Electrical Railway Signalling.—At a meeting of the Institution of Junior Engineers, held at the Westminster Palace Hotel on the 7th inst., the chairman, Mr. H. Bloomfield Vorley presiding, a paper on "Electrical Railway Signalling" was read by Mr. L. G. Ferreira, Member, electrical engineer to the North London Railway. After summarising the history of the development of the single needle by Varley and Spagnoletti, which system formed the basis of nearly all visual signalling apparatus, and briefly describing the various instruments for transmitting messages, the author proceeded to consider the working of the "absolute block system," mentioning the various block instruments in use. As instancing the great amount of work required to be done by the instruments on an urban railway, it was stated that on some lines 16 beats were given and received on the bells, and three movements of the needle made to signal the passage of each train, and where there were four sets of rails, the number of trains per 24 hours might run into four figures. It was of the highest importance, therefore, that the instruments should be of sound mechanical, as well as electrical design, to stand wear and tear, and for the parts to be interchangeable, so that in case of failure they could be easily and quickly replaced. A detailed description was then given of the block instrument designed by the author, in conjunction with Mr. H. J. Pryce, the locomotive superintendent of the North London Railway, which line was now worked throughout by it. A pair of instruments were shown in actual operation at the meeting, and the various parts open to examination. In this instrument the needles had an angular movement of nearly 90 instead of the usual 30, and when the circuit was opened they resumed the normal position, not only by gravity, but by magnetic attraction. The needle arbor carried a cylinder of soft iron, slotted at diametrically opposite points. A permanent magnet had its poles brought close to the cylinder at the extremities of the vertical diameter, and an electro-magnet had its poles similarly arranged horizontally. When there was no current flowing through the electro-magnet, the cylinder took up a position with the slots central to the permanent magnet poles, owing to the two halves tending to arrange themselves in the direction of the lines of force, and the needle was thus held in a vertical position; but when a current was passing through the electro-magnet, the direction of lines of force were altered, and the cylinder turned through an angle of 45. In order to minimise the effect of any residual magnetism in the electro-magnet, the cylinder was reduced in width for some distance midway by the half circumference between the slots. By so doing, less of its area was exposed to the action of the electro-magnet when the needle was in a vertical position, and a differential effect was produced, the permanent magnet having a greater effect on the cylinder when within a few degrees of its normal position, and the electro-magnet the greater effect when the cylinder had revolved sufficiently to bring the full width near its poles. To prevent the needle being moved without giving an audible signal, the ringing key was arranged to lock the commutator so that at least one ring must be given on the bell before the needles could be moved. The ringing key was so arranged that all the contacts were made by rounded pins rubbing on springs with cylindrical tops, which ensured a perfectly clean surface for the actual contact, as any sparking or oxidation occurred on one part of the same, and the point of contact travelled round as the key moved, and finally rested at another place on the surface of both pin and spring. The actual duration of the contact was also much longer than with a butting contact, and thus allowed the instrument to be worked much quicker. There was a special arrangement for junctions to so lock one instrument with another that trains could not be accepted from two cabins on converging lines at the same time. The paper then dealt with repeaters and light indicators, and described the form and arrangement of circuits mostly in use, after which the step-by-step train describer was briefly referred to. Telephones, the methods of grouping them so as to obtain intercommunication between each and all the cabins on a railway were then considered, special mention being made of the conditions necessary to arrive at the best acoustic results. The method recommended was an arrangement by which the telephones were grouped between two wires in "multiple," in section of six or eight, with special switches, to join up one section to the next, the relays being wound to a high resistance (varying in proportion to that of the line wire and their relative distances apart) also in "multiple." In the discussion which followed the reading of the paper, the chairman, Mr. J. G. Sneath, Mr. Smith, Mr. L. Rugg, Mr. A. H. Stanley, Mr. A. W. Marshall, Mr. J. N. Boot, Mr. R. Marshall and Mr. Evans, took part, and a vote of thanks to the author concluded the proceedings. It was announced that the summer meeting of the Institution would this year be in Ireland, commencing August 14th.

Crystal Palace Imperial Victorian Exhibition.—No place could be more appropriate for a Jubilee Exhibition than the Crystal Palace at Sydenham, consisting as it does in part of the original glass structure erected in Hyde Park for the Great Exhibition originated by the Prince Consort, and opened by Her Majesty on the 1st of May, 1851. Just now, apart from any exhibition, the Palace and grounds are well worth a visit. Important improvements have been recently completed, and a general restoration and re-decoration have rendered the building and its surroundings more attractive than ever. It was originally intended that the Imperial Victorian Exhibition should be opened towards the end of May, but it was found necessary, in order to secure the presence of a member of the Royal Family, to have the opening ceremony at an earlier date, and so the 6th was fixed upon as the most convenient date. Accordingly on Thursday last the Exhibition was declared open by H.R.H. Princess Christian. Although the arrangement of the special exhibits is at present incomplete, there are indications that many objects of great interest will be brought together in the various departments of the Exhibition. A specially interesting display is that of the Thames Ironworks and Shipbuilding Company, consisting of models of some of the representative war ships recently built by the company, and similar contributions are sent by Armstrong, Mitchell and Co., Earle's Shipbuilding Company, and others. A model of the Southampton Docks is sent by the London and South Western Railway Company. The Electrical Department will consist principally of the historical collection of the General Post Office, which is becoming tolerably familiar to the public, and some demonstrations of electrical cookery by the Edison & Swan Company and by Mr. Dowsing.

Submarine Collision.—The *Gustave Zede*, a submarine vessel propelled electrically, while manœuvring under water on Wednesday about Toulon, ran into a torpedo boat and seriously damaged her and injured the stokers. The *Daily Mail* says that since the launch of the *Gustave Zede* she has had frequent mishaps to her accumulators.

Opening of the Brussels Exhibition by the King of the Belgians.—Since the so-called official opening, the Exhibition authorities have made very great exertions to get the Exhibition into something like order for the opening by the King. Nearly all the foreign sections, which consist of 12,000 exhibitors belonging to 25 nations, managed to complete their exhibits. The King, accompanied by all the chief ministers, arrived at 3 o'clock, and after inspecting the Belgian section, walked through the centre of all the others. He was received in the British section by H.M. Minister, Sir Francis Plunkett, G.C.M.G., and Mr. James Dredge, the executive commissioner of the section, who pointed out to him the chief exhibits. The King was most interested in the share certificates shown by Messrs. Waterlow Bros. & Layton, Dewar's whiskey, and in the exhibits of Messrs. Mappin & Webb, who are showing an exhibition cup and other prizes for the Tervueren Lawn Tennis Tournament. The only electrical firms in the English section are Messrs. C. A. Parsons & Co., of Newcastle-on-Tyne, who are showing a direct-coupled engine and dynamo with magnetic governing gear, and Messrs. W. T. Glover & Co., of Salford, Manchester, who make an exceedingly good show of every class of electrical wires and cables. They make a speciality of their patent "Diatrine" cable, and also their patent system of welding copper, and have an interesting collection of every form of armature bars. They also show Howard's tables, showing the size of wire necessary for any given current with a sectional area of 1,000 amperes per square inch. It may be interesting to English visitors to Brussels to know that during the Exhibition the ELECTRICAL REVIEW can be obtained at 7, Rue de la Pépinière, Brussels.

Copper Consumption.—The course of the market for copper is of great interest at all times to electricians generally, and at the present moment, says the New York *Electrical Engineer*, the conditions present a problem more than usually worthy of study. Copper enters so largely into all classes of heavy electrical work, that a slight variation in price causes an appreciable difference in the calculations. The subjoined table gives an idea how things have been going in recent years:—

COPPER CONSUMPTION.—METRIC TONS.

	1893.	1894.	1895.	1896.	Increase or decrease.
Germany	60,513	62,955	70,349	85,371	+ 14,922
France	33,886	31,837	40,323	49,007	+ 8,684
England	96,615	90,069	91,084	115,557	+ 24,473
United States ...	77,433	94,511	108,000	93,698	− 14,302
Totals ...	268,447	279,372	309,756	343,633	+ 33,777
World's production	303,530	324,405	334,105	370,000	...

The question arises, How far is recovery in consumption going this year in the United States, and what will be the effect on prices? The range has been as follows:—For Lake Copper, 11·55 cents in 1892, 10·75 in 1893, 9·56 in 1894, 10·75 in 1895, and 10·88 in 1896. Prices have been stiffening here (America) for some time, and apparently with reason, consumption having easily kept up with production so far. At the present time, electrical work here has been exhibiting many signs of renewed hope and activity, while in Europe the new *régime* of electric traction has but barely begun to be active.

Electrical Trades Union.—Mr. F. E. Sims, the general secretary, informs us that as a result of negotiations undertaken by the Union on behalf of its members in the employ of Messrs. Thomas Parker, Limited, electrical engineers, Wolverhampton, the firm "have conceded a very substantial advance in wages to the men employed in their winding department; these improved conditions have benefited 63 of the members of the Union." Branches of the Union have recently been opened at Birmingham and Liverpool.

Farewell Dinner.—Last Saturday, over 40 of the leading officials and staff of the Electric Construction Company, Wolverhampton, went for a pleasant trip, and dined at the "Bradford Arms," the occasion being specially arranged as a complimentary send-off to Mr. R. Johnston, who is leaving Wolverhampton to take up the position of manager of the works' offices of Callender's Cable and Construction Company, Limited, London.

Correction.—In the fifth paragraph of last week's article on "Enclosed Globe Arc Lamps for Street Lighting," in the last line but one for the words, "*removed* every second or third, &c.," read "*renewed* every, &c."

Lectures.—In connection with the Royal Dublin Society the first of a series of six juvenile lectures on "Magnetism and Electricity" was delivered at Dublin, on 10th inst., by Mr. Wm. Brown, B.Sc.

Personal.—Mr. W. H. Fowler, Wh.Sc., Assoc.M.Inst.C.E., M.I.Mech.E, M. Iron and Steel Inst., &c., late editor of the *Practical Engineer*, informs us that he has commenced practice as consulting engineer at Hodson's Court, Corporation Street, Manchester. Mr. Fowler has had upwards of 25 years' experience in the design, construction, inspection and working of steam boilers, engines, pumps and motive power plant and machinery.

Fatality.—Mr. Philip Osler, who was in the employ of the Birmingham Electricity Supply Company, met with a fatal accident last week while engaged putting an electric light installation into the new General Hospital. He fell through a window a distance of about 20 feet to the floor of a corridor.

Tramway Appointment.—The Leeds Corporation are in want of a chief electrical engineer to take charge of the electrical tramways, seven miles in extent, with probability of extension to 40 miles. See our "Official Notices."

The Northern Society of Electrical Engineers.—On Monday next, 17th inst., at 8 o'clock, a paper on "Transmission of Power in Factories by Electricity" will be read by Mr. S. V. Clirehugh, Member, at the Palatine Hotel, Manchester.

Bow Baths to be Electrically Lighted.—The "extravagant progressives" (to quote the Hooley *Sun*) have succeeded in carrying a motion to have the public baths lighted electrically at a cost of about £1,000. Plans and estimates will be drawn up by the Baths Committee.

NEW COMPANIES REGISTERED.

Mexican Electric Works, Limited (52,281).—Registered April 27th with capital of £320,000 in £5 shares, to adopt two agreements with Siemens & Halske, of Berlin, and to carry on the business of an electric light and power company in the United States of Mexico and elsewhere in America. The subscribers (with one share each) are:—F. W. Lunau, 29, Christchurch Road, Streatham, director of company; J. MacAndrew, Dudley House, Harrow-on-the-Hill, gentleman; A. Naylor, Amwellbury, Ware, Herts, gentleman; C. von Siemens, 12, Queen Anne's Gate, S.W., M.I.C.E.; G. W. Mueller, Potsdamerstr, 121a, Berlin; A. Ellert, 3, Whitehall Court, S.W., gentleman; H. L. Hopkinson, 27, Clement's Lane, E.C., solicitor. The number of directors is not to be less than five nor more than seven. The first are the first five subscribers; qualification £500; remuneration £2,000 per annum, divisible. Registered by Hopkinson & Oppenheimer, 27, Clement's Lane, E.C.

British Insulated Wire Company, Limited (52,285).—Registered April 28th, with capital £400,000 in £5 shares, to acquire the business of the British Insulated Wire Company, Limited (incorporated in 1890), to enter into an agreement with the said company, and to carry on the business of manufacturers of, and dealers in, wires, cables, and lines of all kinds, electricians, mechanical engineers, suppliers of electricity, &c. The subscribers (with one share each) are:—W. M. Brigg, Hawkstone, Keighley, merchant; E. Muspratt, 5, Windsor Buildings, George Street, Liverpool, gentleman; J. E. Pearson, 63, Catherine Street, Liverpool, gentleman; J. Batherton, Manhattan, Rainhill, Lancashire, manufacturer; C. P. S. Sparks, Hollinwood, Lancashire, engineer; H. P. Boulnois, 7, Devonshire Road, Prince's Park, Liverpool, civil engineer; F. J. Leslie, 15, Union Court, Liverpool, solicitor. The number of directors is not to be less than three nor more than seven; the first are Z. de Ferranti, T. Snape, and the first four subscribers; qualification, £500; remuneration, £200 each per annum (£250 for the chairman). Registered by F. J. Leslie & Co., 15, Union Court, Liverpool.

Morley Electrical Engineering Company, Limited (52,338).—Registered May 3rd with capital £5,000, in £1 shares, to acquire the business of Graham, Chapman & Co., of Morley, near Leeds, to enter into a certain agreement, and to carry on the business of electrical engineers, electrical apparatus manufacturers, machinists, fitters, millwrights, &c. The subscribers (with one share each) are: W. M. Rennie, Stoneleigh, Ecclesfield, Bradford, spinner; Mrs. R. Rennie, Stoneleigh, Ecclesfield, Bradford; Miss C. Rennie, Stoneleigh, Ecclesfield, Bradford; H. Fox, 47, Southfield Square, Bradford, electrical engineer; A. C. Fox, 47, Southfield Square, Bradford, accountant; J. Graham, 59, Zoar Street, Morley, electrical engineer; A. Graham, Elland Road, Churwell, electrical engineer. The number of directors is not to be less than three, nor more than five. The first are W. M. Rennie (with 10s. per week), J. Graham (with £3 per week), and H. Fox (with £3 per week); qualification, £200. Registered by Waterlow Bros. & Layton, Limited, Birchin Lane, E.C.

Mardy Electric Light Company, Limited (52,361).—Registered May 3rd with capital £2,000 in £1 shares to carry on at Mardy, Glamorgan, and elsewhere the business of an electric light company, electricians, mechanical engineers, &c. The subscribers (with one share each) are:—B. Davies, Mardy, merchant; T. Thomas, Mardy, butcher; J. Jenkins, Mardy, builder; E. Griffiths, Mardy, draper; T. J. Davies, Mardy, draper; J. S. Richards, Mardy, grocer; F. Devonald, Mardy, outfitter. Table "A" mainly applies. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C.; registered office, Mardy, Glamorgan.

Henry F. Joel & Co. and Thomas Potter & Sons United, Limited (52,431).—Registered May 7th with capital of £20,000, in 10,000 shares of £1, and 1,000 preferred shares of £10 each, to acquire and carry on the business of electrical and mechanical engineers carried on by Henry F. Joel & Co. at 31, Wilson Street, Finsbury, and the business of general engineers and art metal workers, lately carried on by Thomas Potter & Sons, Limited, and now by H. F. Joel & Co. at 43, 44, and 45, South Molton Street, W., and to adopt an agreement with H. F. Joel and T. W. Potter. The subscribers (with one share each) are:—H. F. Joel, 31, Wilson Street, Finsbury, electrical engineer; T. W. Potter, 44, South Molton Street, W., engineer; H. Saunders, 117, Ashmore Road, Harrow Road, W., clerk; W. F. Smith, 65, Warren Road, Leyton, electrical engineer; W. McAthy, 21, Kingswood Road, Wimbledon, accountant; V. Baldwin, 29, Netley Road, Walthamstow, storekeeper; G. W. Puttnam,

56, Mildmay Street, N., engineer. The number of directors is not to be less than two nor more than seven; the first are H. F. Joel and T. W. Potter; qualification £500; remuneration £300 each per annum. Registered by Potter & Heath, 34, Finsbury Pavement, E.C.

Henry Botten, Limited (52,405).—Registered May 6th, with capital £10,000 in £1 shares, to acquire and carry on the business of an electrical and mechanical engineer, iron and brass founder, and manufacturer of, and dealer in, electric, magnetic, telegraphic, telephonic, and other apparatus, carried on by H. Botten, at 39, Lime Street, E.C., and Red Post Lane, East Ham, E. The subscribers (with one share each) are:—G. W. MacAvoy, 7, Inverness Terrace, Hurlingham, S.W., gentleman; J. K. Rigby, 154, Palmerston Buildings, E.C., chartered accountant; Mrs. M. Morgan, 115, New Bond Street, W.; R. Edmondson, 1, Pump Court, Temple, E.C., barrister; R. H. Hargreaves, 1, Mitre Court, Temple, E.C., solicitor; R. Wilkinson, 24, Kensington Crescent, W., gentleman; D. H. Pettitt, 110, St. Martin's Lane, W.C., solicitor. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £100; remuneration, £50 each per annum (£100 for the chairman), and a share in the profits. Registered by E. J. Evershed, 1, Mitre Court, Temple, E.C.

French Improved Electric Glow Lamp Syndicate, Limited (52,410).—Registered May 6th, with capital of £2,500 in £1 shares, to adopt an agreement with The Improved Electric Glow Lamp Company, Limited, and to carry on the business of electrical engineers, manufacturers, and contractors in France and her colonies. The subscribers (with one share each) are:—A. Barnes, 25, Lydford Road, St. Peter's Park, W., electrical engineer; F. L. Alexander, Selhurst Road, South Norwood, clerk; B. Clasen, Wallace Road, Canonbury, N., clerk; H. G. Hine, 8, Ellingham Road, Stratford, E., clerk; S. Crossley, 61, Waterloo Road, S.E., warehouseman; R. M. C. O'Inglis, 26, Palace Street, Buckingham Gate, secretary; E. Thormahlen, 13, Emperor's Gate, S.W., manager. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification £100. Registered by Snell & Co., 1 and 2, George Street, E.C.

CITY NOTES.

Brazilian Submarine Telegraph Company, Limited.

The ordinary meeting of the company was held at Winchester House on Wednesday last, Lord Sackville A. Cecil presiding.

The CHAIRMAN, in moving the adoption of the report, stated that the receipts for the half-year ended December 31st last were £88,973, showing a decrease of £3,098 on those of the previous half-year. The receipts from messages exhibited a decrease of £3,634, and those from interest, rents, transfer fees, and dividends on shares in other telegraph companies an increase of £536, making the net decrease he had stated. Three causes had adversely affected the income from messages. There was an interruption of the route of the Western and Brazilian Company on the coast of Brazil from September 4th to October 2nd. They were informed by the Western Company that the interruptions of the cables were due to earthquakes or other form of seismic disturbance of the ocean bed affecting the whole of the extensive coast line of Brazil. The second cause was keen competition in the River Plate districts, and the third cause was a further and continued fall in the exchange value of the currency collected in Brazil. Notwithstanding the falling off in message receipts, they carried about 34,000 more words than in the previous six months. The exchange value of the milrei had ranged from 9$\frac{1}{16}$d. to 7$\frac{7}{8}$d., and it was now about 7$\frac{3}{8}$d. The rate to Pernambuco was 3s. 6d. and less than 2s. from that place, the average rate being, therefore, about 2s. 8d. per word. On July 1st next, under the Buda Pesth revision of the International Telegraph Conference, certain changes were to be made in the basis of collection, which would no doubt lead to results more equitable as between the senders on either side of the Atlantic. Compared with the receipts for the December half of 1895, the decrease in the receipts of the half-year now under review was £17,194; but in the second half of 1895 tariffs higher by about 6d. per word were collected for two months, and the exchange value of the Brazilian currency averaged 10$\frac{5}{8}$d., against 8$\frac{11}{16}$d. Their total expenses in the half-year had been £21,090, showing an increase of £1,880 compared with those for the previous six months. Neither half-year contained any expense for repairs of cables—a fact upon which they might congratulate themselves. On the period now under review certain expenses had fallen, which did not indicate anything of the character of permanent or continuing charges. After providing for debenture interest, sinking fund, and income-tax, there was a balance of £63,214. Two quarterly interim dividends at the rate of 6 per cent. per annum had been paid, absorbing £39,000, a transfer of £20,000 had been made to the reserve fund, and the balance of the half-year's profits, £4,214, was carried forward. With £11,060 brought forward from June 30th last, they had £15,274 with which they commenced the current half-year. So far as the present half-year had gone, he regretted that he could not report any improvement in the receipts; on the contrary, they still had a decrease compared with the immediately preceding half-year. On the other hand he was glad to say that they had not been called upon to meet any expenditure for repairs of cables. Referring to the International Submarine Telegraph Memorial to the late Sir John Pender, he stated that the directors had unanimously felt, in the circumstances, that they could rely on the shareholders' support when the board ventured to anticipate their wishes by putting this company's name down for a contribution of £500, subject to the shareholders' confirmation.

After referring to general matters, Mr. J. DENISON PENDER seconded the resolution, which was carried unanimously.

A resolution was afterwards passed granting a donation of 100 guineas towards the Prince of Wales's Hospital Fund.

The Western and Brazilian Telegraph Company, Limited.

THE report of the directors to be presented at the thirty-third ordinary general meeting of the company states that the total earnings amount to £71,315 12s. 2d., as against £80,315 2s. 10d., showing a decrease of £8,999 10s. 8d. compared with the half-year to December 31st, 1895. The working expenses amount to £38,160 19s. 4d., as against £38,122 9s. 11d., an increase of £38 9s. 5d. Though not relating to the half-year under review, the success of the debenture re-organisation scheme necessitates reference to it in the present report. Out of a total of £338,800 "A" and "B" debentures outstanding, assents have been received to the extent of £328,500, leaving only the small balance unexchanged of £10,300. Hitherto it has been the custom to place an annual amount to the credit of the Debenture Redemption Fund, but it will in future only be necessary to set aside at the end of each year the annual sinking fund of £2,159 for the redemption of the new debenture stock, together with such small sum as may be required to pay off the remaining old debentures as and when drawn. After payment of the drawing there will remain at the credit of the debenture redemption fund a balance of £4,935 10s., which it is proposed should be carried, in the next half-yearly account, to the credit of the reserve fund. The directors regret to have to report that no dividend has been received on the shares held in the Platino Company during the past year on account of the heavy falling off in the traffic, together with the loss on exchange. They are glad to state there is an improvement in the traffic during the current year. Including the amount brought forward from June 30th, 1896 (£3,530 5s. 7d.), the balance to the credit of the revenue account is £36,684 18s. 5d., from which has been deducted £10,671 for debenture interest, leaving £26,013 18s. 5d., of which £5,000 has been placed to the reserve fund. The directors now recommend the payment of 3s. per share, free of income tax for the half-year on the ordinary shares, making, with the dividend paid in November last, £2 per cent. for the year, leaving a balance of £6,405 11s. 5d. to be carried forward. In the case of shares which have been divided into preferred and deferred, the 3s. per share now recommended will be payable to the preferred shareholders. The loss on exchange during the half-year has been intensified, the average rate being lower than in any period previously recorded. There is no change in the position of affairs between the Government of Brazil and the company as to the purchase of ihe cables. The eighth annual drawing of the "A" and "B" debentures took place at the company's offices on January 18th last, in the presence of Mr. W. E. Venn, notary, when debentures amounting to £16,900 were drawn and have since been paid off at par.

The West India and Panama Telegraph Company, Limited.

THE report of the directors for the half-year ended December 31st, 1896, to be submitted to the fortieth ordinary general meeting, May 19th, 1897, states:—The directors submit the accounts for the six months ended December 31st, 1896. The amount to credit of revenue is £34,053 13s. 6d., against £33,558 3s. for the corresponding half-year of 1895, and the expenses have been £21,398 15s. 4d., against £19,676 5s. 11d., leaving a balance of £12,654 18s. 2d., which, with £1,968 17s. 6d. brought from last account, makes a total of £14,623 15s. 8d., with which it is proposed to deal as follows:—

	£	s.	d.
First Preference Shares—			
Dividend, six months to December 31st, 6s. per share	10,368	18	0
Second Preference Shares—			
Dividend, six months to December 31st, 6s. per share	1,400	14	0
Ordinary Shares—			
6d. per share (free of income-tax)	2,208	0	6
Balance to current half-year's account ...	646	3	2
	£14,623	15	8

The traffic receipts for the six months show an increase of £984 11s. 11d., as compared with the corresponding period. The expenses of repairing cables during the half-year amounted to £9,015 14s. 7d., being £1,918 5s. 4d. more than those for the corresponding period. This increase is due to the company's ss. *Grappler* having been engaged on cable work, in unusually deep water, 147 days, as compared with 96 days in 1895. In the corresponding period her expenses were also reduced by her being credited with the freight on a cargo of cable sent from the Thames to the West Indies for stock. The ss. *Duchess of Marlborough* is still laid up in London, out of commission. The shareholders have been informed in previous reports of the partial competition of the Compagnie Française des Cables Télégraphiques, to whom the subsidies previously paid by the French West India colonies to this company, viz., £4,000 per annum, have been transferred. This competition assumed a more active shape in

December last, when the French Company, in conjunction with its American associates, and supported by a large subsidy from the French Government, laid a cable from New York to Hayti, and thus completed the connection with the cables it had already laid in the West Indies. The material support granted to our competitors by their Home and Colonial Governments enabled them to reduce the tariff to the West Indies, and this company was consequently compelled to make similar reductions to retain its traffic for the route prescribed by the Legislative Acts of our Colonies. As, however, the French company's cable between Hayti and Martinique has been interrupted since December, 1895, the full effect of the competition has not yet been experienced, for the traffic of the French Colonies has, owing to the above interruption, still to avail itself of this company's lines to Cuba, where they meet a branch of the French system. The directors are thus again enabled to gauge the effect of tariff reductions on the traffic of the West Indies; and this further experience confirms that of previous reductions, viz, that they have no influence in developing the telegraphic correspondence of the region, and that they entail a diminution of revenue. When the Hayti-Martinique cable of the French company is repaired, the company will then have to face the full competition of a line supported by the large subsidy of its Home Government, an advantage not enjoyed by this company, which is, moreover, exceptionally weighted by conditions imposed upon it by the Colonies. Under the powers given to them by the articles of association, the directors have elected to a seat on the board Mr. Walter Bishop Kingsford, who has on two occasions visited the West Indies as a special representative of the company. In accordance with the articles of association, Charles William Earle, Esq., retires at this meeting, and offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

Elmore's German and Austro-Hungarian Metal Company, Limited.

The sixth annual ordinary general meeting of Elmore's German and Austro-Hungarian Metal Company, Limited, was held last Friday at Winchester House, Mr. John MacFarlan in the chair.

The Chairman said: The writing off of the sum of £25,618 8s. 10d. from premium and reserve accounts to the credit of patent account was deemed advisable, as in the directors opinion this item was higher than it should be, and the reduction did not affect the pockets of the shareholders, while it was entirely in their interests that the reduction should be made. The sum of £4,166 13s. 4d. due to the vendor of the property at Schladern had been paid, but they had to borrow £4,000 from their bankers on the guarantee of two of the directors and three shareholders. That amount had since been repaid, and the only charges upon the property at Schladern are those held as security for the loan. The general charges other than debenture interest are lower, and that, although the work of the company during the past year had demanded much of their time, the directors had accepted half fees. As to the Metal Company, they would have liked to report a little more progress. Still it must be remembered that the increase in the sales was effected by the same plant as that working in 1895, and after comparing the present balance-sheet with those of past years there was now no question, first, as to the quality of the goods produced, and secondly, that they could be produced at a profit, and at a good profit. He need not comment upon the fact that while the sales were 50 per cent. more than in 1895, the trading profit was 110 per cent. higher, beyond stating it confirmed very clearly that the profits would increase in a greater proportion as the business increased. During the past year another point was settled which, although they had not laid much stress upon, was of importance, the question of the recovery of precious metals. They were able to purchase a certain class of copper from which they recovered and sold no less than 185 ozs. of fine gold, which realised £4 1s. 6d. per ounce, and nearly 6,000 ozs. of silver. They had a contract for six months' purchase of this copper, and as the amount deposited increased the return under this head will be also greater. They were in receipt of more orders than they could even now possibly accept, and there was no reason why the supply should not be kept up. He said last year that from a shareholder's point of view progress had been slow, and disappointments grievous, and even last year they still had difficulties. They thought they were certain not to have one dry summer following another, but this did occur, and during the very busiest time they could only work at a very slow rate. Stock-in-trade and book debts amounted to nearly £16,000. The commission and interest paid on loans other than debentures was alone sufficient to pay 2½ per cent. dividend to the preference holders, and should have gone into their pockets. Last year they economised as much as possible, and were enabled to purchase and erect 16 large tanks and to pay for them out of current cash, but they could not spare the necessary copper to start them, and it was not until January this year they could be worked. The result is, that the output of saleable tubes has increased by 56½ per cent. for the period from January 1st to April 17th last, as compared with the same time last year. The directors should not be held responsible for the results not being much better. The business was one in which command of capital was necessary, and the shareholders did not see their way to give it. In conclusion, he wished to repeat that although the figures for the past year are not so satisfactory as they could wish, it is a matter for congratulation that they have succeeded in bringing the company to its present position, and it was only the fact that they were confident the company was bound to succeed that gave them the courage to go on with a task that has for the past five years been one continual struggle. They now saw the end of that struggle, and the success of the company, and their approval will be the reward.

After some discussion the report and accounts were adopted.

Submarine Cables Trust, Limited.

The Marquis of Tweeddale presided on Tuesday last at the ordinary general meeting held at Winchester House. In his opening remarks the chairman referred to the death since their last meeting of Sir John Pender, a late trustee, who for many years took a deep interest in everything connected with submarine telegraphy. The vacancy among the trustees thus caused had been filled by the appointment of Sir A. J. Leppoc Cappel. The revenue for the past year had been £22,892, being an increase of £579 over that of the previous year, through their having received a better dividend from their investment in the Anglo-American Telegraph Company. They had also realised £84 for interest on money derived from the sale of Anglo-American telegraph stock, the amount having been temporarily placed on deposit until the proceeds could be reinvested. The total expenses for the year had been £1,063, or £36 less than those of the previous year. Their expenses were £936 less than the amount provided by the trust deed. Their revenue for the year, together with £307 brought forward, had enabled them, after providing for the expenses, to pay £6 10s. per certificate; in other words, they had been able to pay the equivalent of two coupons of £3 each, and to clear off a further sum of 10s. on account of the remaining portion of the overdue coupon. The amount in arrear now was only 10s., which would be gradually paid off if the income derived from their investments was maintained or increased. The trustees, considering that it was expedient for the interest of the certificate-holders to distribute the investments over a larger area, had sold certain trust securities, and it was anticipated that the re-investment of the proceeds derived from the sale of Anglo-American telegraph stock would produce an income rather more than was received from this source last year. They might, therefore, fairly anticipate that the arrears would be cleared off in about a year, and that they would find themselves again able to apply surplus income towards the redemption of certificates. Under the head of "loss on the sale of securities," an entry of £23,338 appeared in the balance-sheet. This was entirely owing to the sale he had referred to of a portion of their holding in Anglo-American telegraph stock, but the loss was more than compensated by the enhanced value of the other securities forming the investments of the trust, which at the present mean price showed an appreciation of no less than 75 per cent.

Mr. J. Denison Pender seconded the motion, which was carried unanimously.

A resolution was afterwards passed confirming the sale and conversion of certain securities and the investment of the proceeds in other securities, as mentioned in the report published in our last issue.

The City of London Electric Lighting Company, Limited.—Mr. J. Cecil Bull (manager and secretary) sends us the following returns relating to this company:—Revenue return, quarter ended March 31st, 1897:—Gross revenue from sale of current for public lighting, quarter ended March 31st, 1897, £3,182; corresponding quarter last year, £3,161; gross revenue from sale of current for private lighting, &c., quarter ended March 31st, 1897, £49,843; corresponding quarter last year, £38,280; gross revenue from other sources (estimated), quarter ended March 31st, 1897, £1,500; corresponding quarter last year, £750; total, quarter ended March 31st, 1897, £54,525; corresponding quarter last year, £42,191; increase, £12,334; equivalent of 8 C.P. lamps connected on March 31st, 1897, 260,936; increase during quarter, 13,151; equivalent of 8 C.P. lamps connected on March 25th, 1896, 207,268; increase during corresponding quarter last year, 11,951.

J. & H. Gwynne, Limited.—The public has this week been invited to subscribe for £50,000 5 per cent. preference (£5 each share), and £50,000 ordinary (£1 each share) capital in this company, the total authorised capital being £135,000. The list was announced to close yesterday for London, and this morning for the country. The company is formed for the purpose of acquiring and extending the business of J. & H. Gwynne, engineers, of Hammersmith and Cannon Street. Mr. John Gwynne will act as managing director for five years, and the other directors are Messrs. John Brownlees, S. H. Farrar, and H. D. Marshall. The secretary is Mr. W. W. Wilkes, and the registered office is 89, Cannon Street, E.C.

African Direct Telegraph Company, Limited.—The numbers are published of the 4 per cent. mortgage debenture bonds of the company for £12,500, which have been drawn at the offices, Winchester House, and which will be paid off at par on July 1st next.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 9th, 1897, were £957; week ending May 10th, 1896, £909; increase, £48; total receipts for half-year, 1897, £19,503; corresponding period, 1896, £17,936; increase, £1,567.

The Great Northern Telegraph Company. The receipts in April, 1897, were £24,000; January 1st to April 30th, 1897, £89,200; corresponding months, 1896, £90,000; corresponding months, 1895, £95,600.

The Liverpool Overhead Railway Company. The receipts for the week ending May 9th, 1897, amounted to £1,316; corresponding week last year, £1,162; increase, £154.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 7th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,226.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, May 5th.	Closing Quotation, May 12th.	Business done during week ended May 12th, 1897. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	103	103¼
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	4½— 5½	4½— 5½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	49 — 52	49 — 52	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	93½— 94½	93½— 94½	94½	93⅝
2,993,560£	Do. do. Defd.	Stock	...	...	...	7⅞— 8	7⅞— 8⅛	7⅞	...
139,680	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	14⅜— 15½	14⅜— 15½	15⅛	14⅜
75,800£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3½— 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	169 —175	173 —177	175	173½
40,000£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	98½— 99½	99½—100½	100	99⅛
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1 3/16— 5/16	1 3/16— 5/16	...	...
15,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	10 — 11	10 — 11	10⅜	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	4⅛	...
5,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	105 —108%	105 —108 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	8½— 9	8½— 9	8 1/16	8 7/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	16¾— 17¼	16¾— 17¼	17 1/16	16⅞
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —106	103 —106	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	127 —130	128½	127½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	%	18 — 18½	18 — 18½	18⅝	18¼
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	100 —104	100 —104	...	...
194,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	128 —131	128 —131	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	100 —104	...	...
107,600£	Do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	101 —104	...	...
306,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	107 —110	107 —110	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110%xd	107 —110 %	107½	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅛%	4⅛%	...	11 — 11½	11 — 11½	11½	11⅛
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17½	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10%	24 — 25	24½— 25½	25⅛	24¼
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	55 — 58	55 — 58	56½	56⅛
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2⅛	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6¼— 6½	6⅜— 6⅝	6⅝	6⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	15⅜	15¼
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	15⅜	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 5/16	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —105	105 —109	106⅜	104½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4¼%	5 %	5 %	⅜— ½	⅜— ½	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4%	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	...	7 — 8	7 — 8	...	...
3,881	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	138½	137
58,880	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½— 3¾	3½— 3¾	...	...
145,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,509	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	...	5 — 6	5 — 6	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	102	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	...	¾ — 1¼	¾ - 1¼	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	103 —108	103 -108	...	...
54,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	7½— 8	7½— 8	7½	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 6¾	6½— 6¾	6⅝	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	1½— 2	1¼— 1¾	...	...
135,280£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	... ...	... ...	...	...
206,460£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	... ...	... ...	...	...
88,321	West India and Panama Teleg., Ltd.	10	½%	⅞%	1 %	⅞— 1⅛	⅞— 1⅛	1⅛	1
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 11½	11 — 11½	11¼	11⅛
4,569	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7	104 —108 xd	104 - 108	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	10½— 11½	10½— 11½	11⅜	11⅛
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6½	6 5/16
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	8¾— 9¼	8¾— 9¼	9⅛	8¾
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	22 — 23	22 — 23	22½	22
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	17½	16⅞
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	130 —135	130 —135	133¾	133½
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12½— 12⅝	12½— 12⅝	12⅝	12⅝
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	14⅜— 15½	14⅜— 15½	15½	14⅞
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	..	14½— 15	14½— 15	14 15/16	14¾
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	7½— 7⅝	7½— 7⅝	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	16½— 17½	16½— 17½	17⅜	17⅛
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	12½— 13½	13 — 14	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —124	120 —124	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	12½— 13½	13 — 14	13⅜	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15 — 16	15 — 16	15⅜	
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½— 10½	10 — 11	10⅜	10
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	5 %	7 %	9 %	13½— 14½	13½— 14½	14¼	13¾

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, May 5th.	Closing Quotation May 12th.	Business done during week ended May 12th, 1897. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	S	2½%	...	...	⅞— 1⅛	⅞— 1⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅜— 1⅝	1⅜— 1⅝	1 7/16	1⅜
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	104 —108	104 —108	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9½— 10	9⅝— 10½	10⅛	10 1/16
207,649	Do. do. do. £6 paid	10	...	...	...	5½— 6	5⅝— 6	5 15/16	...
630,000*l*	City and South London Railway	Stock	1½%	1 3/16%	1 5/16%	58 — 60	58 — 60	60	59¼
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜— 2¼	1⅜— 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅜— 2¼	1⅜— 2¼	1⅜	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1½— 1⅝	1½— 1⅝	1 1/16	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2⅜— 3¼	2⅜— 3¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	¾— 1	⅞— 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 — 13	11 — 13	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½— 19½	18½— 19½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	18½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
58,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½— 21½	20½— 21½	21¼	21⅛
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —107	104 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅝%	2 7/8%	12 13/16— 12 15/16	12 13/16— 12 15/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15 — 15½	15½ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	34 — 37	34 — 37	36¾	35½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜— 11¼	10⅜— 11¼	11¼	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.

Electric Construction Corporation, 6 % Debentures, 104—107.

House-to-House Company, 7 % Preference, of £5, 9½—10.

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 11¾—12¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1½—1⅝.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8½—9. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2½ per cent. (April 8th, 1897).

RAPID CABLE LAYING FOR WAR PURPOSES.*

By Lieut. CRUTCHLEY, R.N.R., and C. SCOTT SNELL.

Submarine telegraphy in any future warfare must inevitably play a very important part.

If the mind can imagine so unusual a state of things, consider what would be the position of Great Britain separated from contact with the world save by steamer alone. Early intelligence in all naval warfare in the past has proved itself invaluable, and there is no reason to believe that it will be of less importance in the future, when the facilities for combination afforded by steam are contrasted with the naval combinations made under sail in the earlier portion of the century.

The object in reading this paper is to elicit an opinion whether in future operations it will be to the advantage of a naval commander-in-chief to have at his disposal the means of establishing communication with either a base, or outlying pickets of ships at a moderate distance, say from 300 to 500 miles. Not only so, but whether the fact of his being able to establish such communication at the fastest speed yet attained by a warship may not be of material value in working out a combination of effective force.

It is claimed by the inventor of this apparatus that he can safely lay a submarine cable at any rate of speed within the compass of the fastest cruiser. This would be so far in excess of anything which has hitherto been accomplished, that some doubt might be expressed as to the possibility of so doing, but that the plan is feasible, is vouched for by so eminent a practical authority, that little doubt can be entertained as to its possibility.

It is needless to say that practical illustration of this would cost more money than it might be convenient to find for such demonstration; but should the verdict given this afternoon be favourable, I have little doubt that such demonstration will be made.

The apparatus is capable of being fitted to a war ship or a properly equipped telegraph ship, or as an alternative there is a temporary arrangement which is capable of being adapted to any vessel at very short notice.

Recent discoveries in electricity have given us greater power in communicating than we have hitherto possessed.

I speak now of the possibility of inducing currents in a cable without making actual metallic contact, and that this can now be done is established beyond any doubt (particulars are given in an appendix); it is, therefore, a further reason why such a scheme as is now brought before you should receive your most earnest attention.

With these few introductory remarks, I will now pass to a description of the apparatus, and will afterwards sketch out one plan of how this might be of the utmost value in war-time; and the reason I select the instance I do, is that by selecting operations in peace, for example, we offend the susceptibilities of no one.

We may with advantage first take into consideration the type of cable proposed to be used, and in connection with this the following from an eminent maker may be quoted:—"As regards the cost of a submarine cable which would suit your proposed scheme, and which it would be possible to lay and lift more than once, we could supply a small bright cable as under:—A conductor of seven tinned copper wires, each No. 22 L.S.G., stranded; insulated with pure and vulcanised India-rubber, sheathed with steel wires, made up in strands of three wires, each No. 20 L.S.G. The price of this cable would be £60 per knot, delivered in tank at our works. The total over all diameter would be 0·45 inch, and the weight 11·4 cwts. dry in air, or 8·75 cwts. when immersed in salt water, the above weights being per knot.

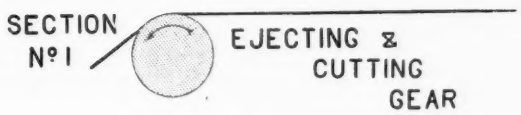
In relation to this matter the mind must be quite disabused of the idea that the cable is to be dragged out of the vessel, as in every-day practice; were this so, the length of the cable, when laid at such a high speed, could not by any means exceed the distance traversed by the ship, it is, however, essential that provision should be made for such a surplus delivery as will admit of inequalities in the sea bottom being provided for, so that no long unsupported spans are likely to exist. At the ordinary speed of cable laying, the cable forms an inclined plane down which, as it were, a percentage of slack can be delivered by loosening the brakes on the retarding gear. At such a speed as 20 knots, it is evident that the angle assumed by the cable must be very small, possibly less than 5°; we therefore find ourselves working under very different conditions.

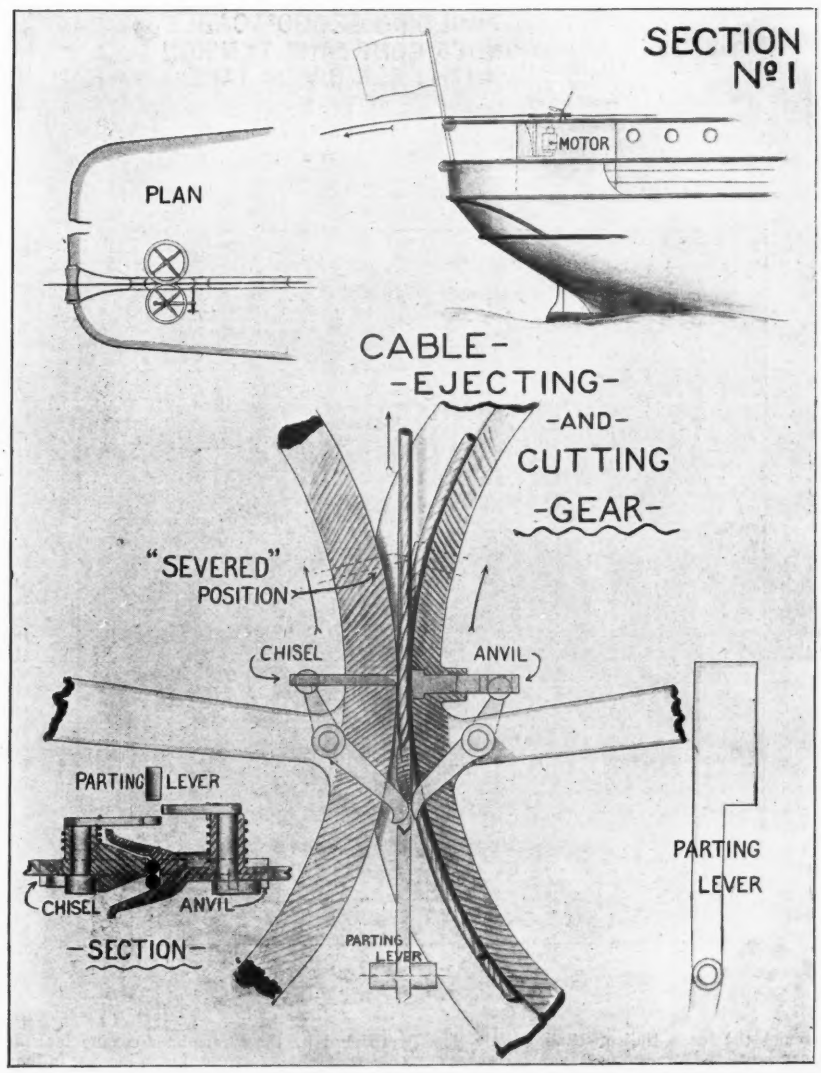
It will not be denied, however, that it would be possible to lay a thread of cotton from such a vessel as the *Lucania* on an Atlantic voyage, providing always that the thread was not dragged out of the ship, but was thrown away from a wheel at the stern, at a rate in excess of the speed of the vessel. No doubt such a fragile material would be soon destroyed by the action of the waves and currents; but nevertheless there is no reason why continuity of delivery into the sea should be imperilled. With the ship at anchor there is, of course, no reason why 21 knots of cotton should not be paid overboard within the hour.

* Read before the Royal United Service Institution on Wednesday, April 28th, 1897. The illustrations are given by permission of the Council of the Institution.

We will now take our electric cable into consideration, and it must be admitted that if this also be similarly handled, we are justified in adopting a similar conclusion; further, although a lengthy term of service is not likely to be required, reliability is a very important factor, and we are therefore justified in delivering overboard a goodly margin of slack; dividend paying considerations, of course, do not obtain.

The mechanical methods to be employed in order to throw overboard cable at the rate proposed require careful consideration. Let us at the outset remember that steel cables for power transmission





purposes are in daily use at such speeds as 80 feet per second, *i.e.*, about double the rate of our maximum demand. There is no reason why the appliances used in power transmitting plants should not, with slight modifications, feed a quantity of cable stored in one position, to another some hundreds of feet away, instead of operating an endless cable. This is exactly what we are contriving to do, in delivering from the hold of the vessel into the sea astern. In our sea service, however, we have extra contingencies to provide for, such as the risk of error in making due allowance in the matter of "slack," thus causing a stress to come upon the cable from without the ship.

The presence of such a strain it is proposed to notify, as well as to make provision against ill effects, by the following arrangement: A pulley at the stern *ejects* the cable overboard, and is driven by a motor capable of exerting only a comparatively small power, and beyond this stern pulley (if we consider the ship from the stern towards the bow), we find a wide drum over which is passing the cable on its way from the hold. In conjunction with this drum, in a manner to be hereafter described, is maintained 2,000 feet of cable under a constant tension; and until this bight of the cable between the stern pulley and the main supply is all paid out, no abnormal stress can be set up on the rest of the cable. As the very lessening of the amount of this bight can be made to increase the supply of steam or other power to the main paying-out engine, if "power" be used for this work, it is only the delay in the responsiveness of such engine and its load that has to be provided for. Now a bight of 2,000 feet would provide an increase of 10 per cent. over the vessel's speed of 20 knots for about 10 minutes, and the question of the sufficiency of the length of the cable held in hand, depends upon how we carry our cable.

For instance, let us suppose we take 300 knots of cable as a convenient unit, which will weigh 180 tons and may be conveniently contained in a compact cylindrical tank, lying longitudinally in the ship. In length and diameter this tank is sufficient to admit of a drum or bobbin rotating within it of the following dimensions:—

Between flanges...	... ...	15½ feet.
Diameter of flanges	... ...	15 "
" of core	... ...	6 "

The capacity would be equal to 300 knots of cable; in size, the tank is about the same as many double-ended boilers.

The driving power may consist of a set of engines capable of indi-

cating, say, 150 H.P., thus giving power enough to enable the fully loaded drum to be given a paying-out speed of 20 knots, from a state of rest, within 100 seconds; or, if already running at that speed, an additional 10 per cent. increase can be effected in 10 seconds, whereas we hold in hand 10 minutes' supply. With the drum fully loaded the revolutions will be about 45 per minute, and with the drum nearly repleted it must be rotated at about 100 revolutions per minute; the command, however, in the latter case is so perfect, that the power is more than ample.

Obviously, if such a drum is arranged in the after hold, a similar one may be adapted to the fore hold, thus admitting of carrying 600 knots.

As this load would be very small for a merchant cruiser or other lightly-armed steamship, she could carry a large stock of coal or other "fleet" requirements.

The idea of a cable running out at 20 knots may be rather startling; therefore particulars of analogous operations are given as an appendix at the end of the paper.

Let us now consider more in detail the means proposed for holding in hand and completely stowing 2,000 cubic feet of cable; this apparatus we will hereafter call the cable accumulator.

In principle it consists of a pair of sheaves over which the cable is led (see No. 1, Section 2), a bight of 2,000 feet being allowed to hang down; to this a constant tension is applied by a weight upon a third sheave. A vertical traverse of a 1,000 feet is obviously impossible on board ship; if, however, the two upper sheaves (see No. 2) are placed side by side, and are of considerable width, *each* sheave constitutes a drum capable of holding 1,000 feet of cable, and we may imagine that by the filling of the drum our third sheave and its weight have been raised until they are in danger of being carried around with the drums. At this point we will dispense with the idea of a weight, and attach our sheave to an arm radiating from the part of the axle between the two drums (see No. 3); the sheave is then free to revolve in a plane tangential to the circumference of the two drums, at the same time it has a clear orbit around them.

Now, by controlling the axle where it projects beyond the two drums (these being loose upon it), we are able to put a retarding force upon the tendency to carry the sheave around the drums, thus effecting exactly the same result as attained by the weight previously referred to. Assuming that our system has now become as shown in

Diagram 1.*

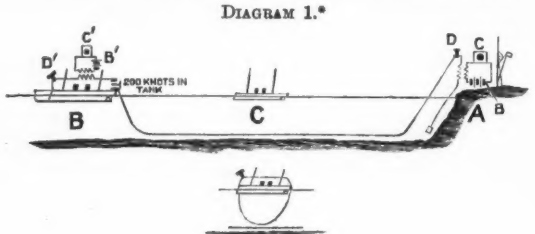


Diagram 2.*

No. 3, Section 2, and that the weight, w, there represents the effect of a small hydraulic, steam or electric motor, it will be seen that if the rate of supply of cable at A is, say, 20 feet per second, whilst the rate of demand at B is 21 feet per second, the tangential sheave will be carried around against the torsion of its motor, by which will be maintained a steady retarding stress. In 2,000 seconds of time both drums will be practically empty; for each complete revolution of the arm will take one turn off each drum. This arm and accessories

The following problem was submitted to Prof. J. Blake:—

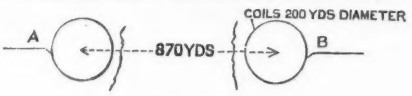
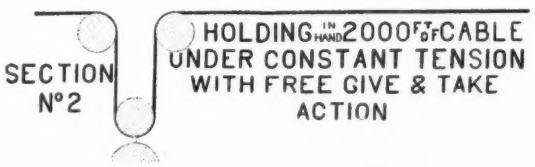
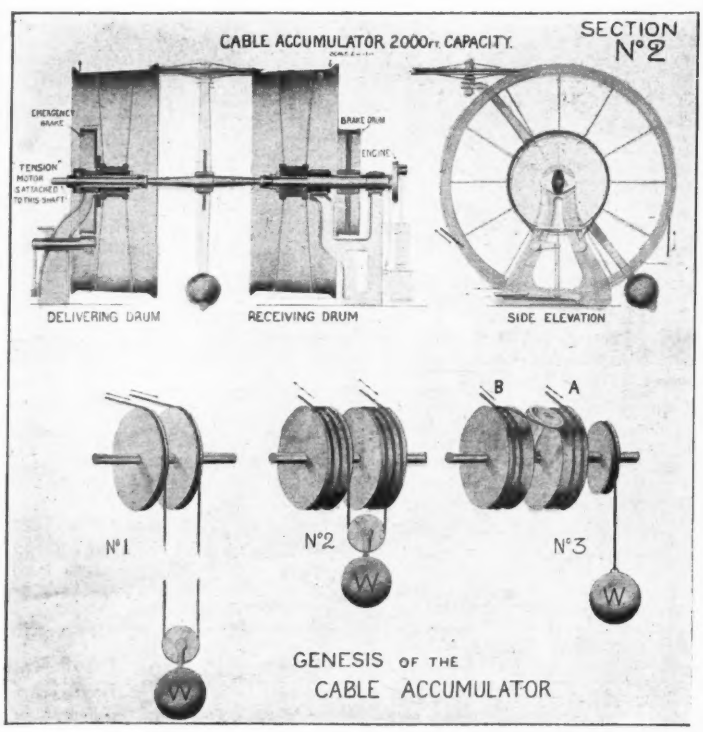


Diagram 3.*

will be rotating at a speed of two revolutions per minute; and meantime the two drums and the sheave are making very rapid revolutions on their separate axes, quite independently of any other motion.





To prevent such a climax as the total clearance of all the turns of cable from off the drums, any movement of the torsion producing motor, typified by weight, w, will be the signal to the man in charge of the engine operating the main power rotating drum, to readjust the engine speed, the duty of this particular driver being simply to so regulate his engine as to keep the drums adequately supplied with cable. This might be automatically effected if wished, but might increase risks. It now becomes plain that no strain above a prearranged amount, that amount in fact to which the motor controlling the tangent sheave may be adjusted, can occur; even indeed when there is an error of judgment as to the amount of slack required.

In this system the rate of delivery overboard is governed by the speed given to the stern pulley, and in the event of an outside stress occurring, due, of course, to insufficient speed in paying out, the stern pulley acquires an increased rate of revolution, and the speed indicator attached to it fails to tally with a standard instrument to which this driver is supposed to work. Should he then even cut off his power supply entirely, he will produce no diminution of speed. No injury, however, occurs to the cable on account of the flexibility as it were, produced by the accumulator coming into play, but the officer in charge must now arrange for an increase in the driving speed.

The electrical controlling instrument designed for use in conjunction with the work, is shown in the drawings, and described in an Appendix, but time does not admit of a description at this point. It may, however, be briefly described as an instrument which enables the rate of speed as registered by the log to be indicated to the driver with such a plus or minus reading as shall cause proper allowance to be made for tides, &c. The bearings for a drum of the weight proposed become a matter of very great importance, and the inventor has therefore requested the Roller Bearing Company to submit a special design and model which are shown. The automatic mechanism inside the main tank, for ensuring regularity in laying each convolution of cable as receiver, is shown and described in the Appendix.

As an alternative plan for carrying the cable, a number of rigid drums of about 25 knots capacity each, are proposed, the height and diameter being such that they may be readily stowed between decks; this system is fully described in the Appendix, but in either system there is the minimum of delay in taking in cable, an important item in war operations; so important, indeed, that the ordinary methods of handling cable, both in taking in a supply or in paying out, would

* The diagrams are referred to in the latter part of the paper.

be under serious disadvantage. In the latter case, protection by strong convoy would be needed, beside making the operations in hand plain to the enemy's scouts. The one case in point, as an illustration of the value of this invention, is taken from the records at our naval manœuvres of 1888, and here I quote largely from the "Navy and the Nation."

"For the purpose of this experiment, it was assumed that war was imminent between two naval powers; one, the weaker, represented by Ireland, the other by Great Britain. The enemy was fitting out two fleets in Bantry Bay and Lough Swilly respectively, and two British fleets with their bases at Milford Haven and Lamlash were organised for the purpose of blockading him in his ports."

It is unnecessary before this audience to say more as to similarities of geographical positions.

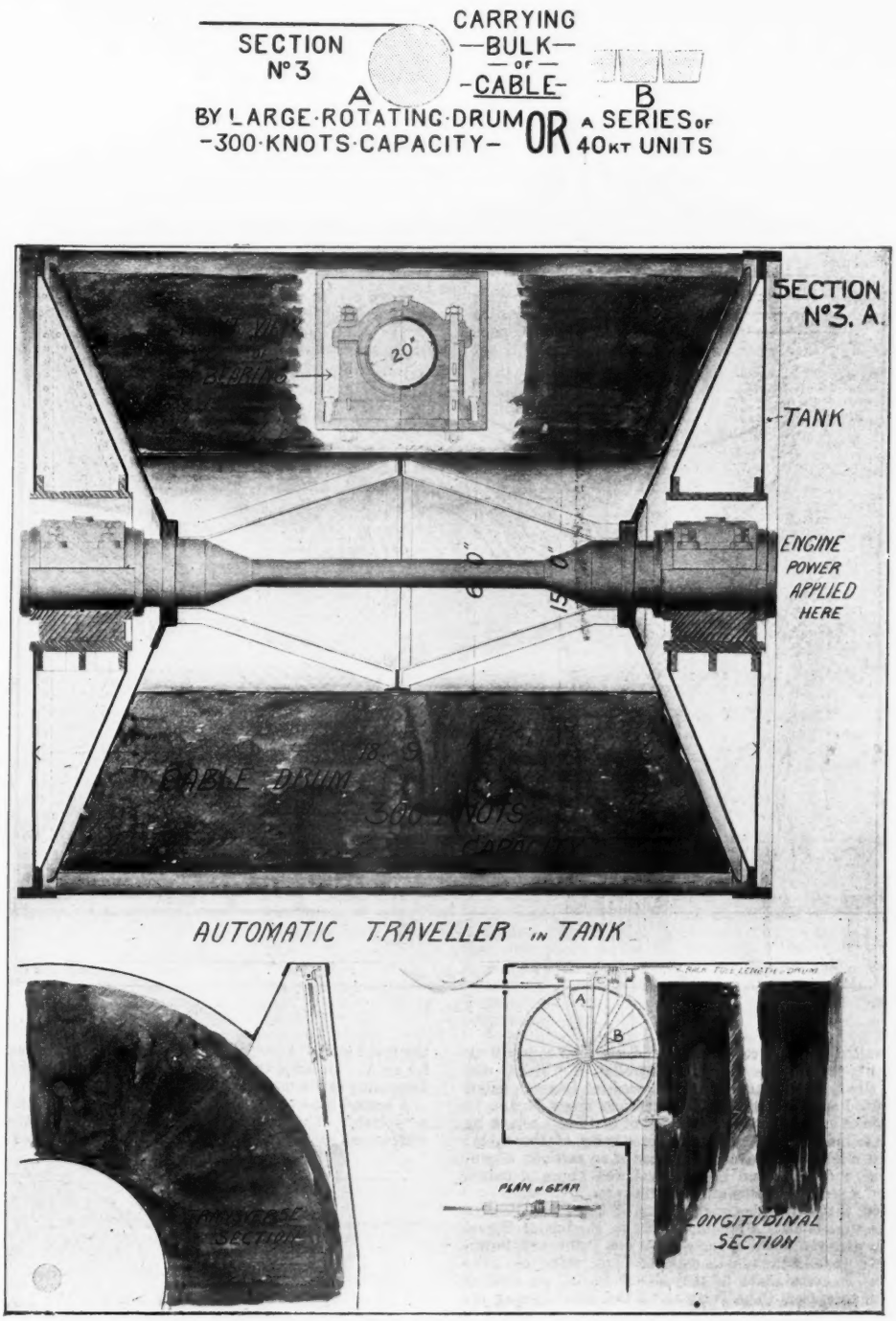
(To be continued.)

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

DISTURBANCE OF SUBMARINE CABLE WORKING BY ELECTRIC TRAMWAYS. By A. P. TROTTER, Member. (Read May 13th, 1897.)

On August 6th, 1896, the electric tramway service in Cape Town was opened, the cars running from the boundary of the suburb of Mowbray to the corner of Darling Street and Adderley Street (see fig. 1). The rails are 81 lbs. to the yard, and are double bonded with "Chicago" bonds, except between Adderley Street and the tramway works, where the track is double and the rails are triply bonded. A test made on September 2nd showed that the fall of volts on the rails was from half a volt to about 1 volt. From two to three-tenths of an ampere passed between the earth plates at the



works and the dynamos. There are two earth plates, but by a mistake only one wire was brought from them. A test made between the earth plates and the feed service of the boilers showed that 2 volts caused 2½ amperes to pass. The works are about 1¼ miles from Adderley Street.

The submarine cable is laid in a loop round Table Bay (fig. 1), in order to avoid anchorages, and is landed at the foot of Adderley Street at a cable hut. From this hut a pair of cables are laid under the street to the Standard Bank, at the corner of Adderley Street and Darling Street, a distance of about 430 yards. The office of the Eastern and South African Telegraph Company is situated in the Standard Bank building, and looks out on to Darling Street. The first mile of the cable is at a mean distance of about half a mile from the tramway.

As soon as the tramway service began, the working of the siphon recorder was found to be seriously disturbed. Numerous "kicks" occurred, and these being superimposed on the received signals made it difficult and often impossible to decipher them. On August 14th I visited the office of the cable company with the Postmaster-General, and witnessed the disturbances. The then terminus of the tramways was almost immediately opposite the window of the cable company's office, and the movement of the driver's hand on the controller of the car could be watched while standing by the siphon

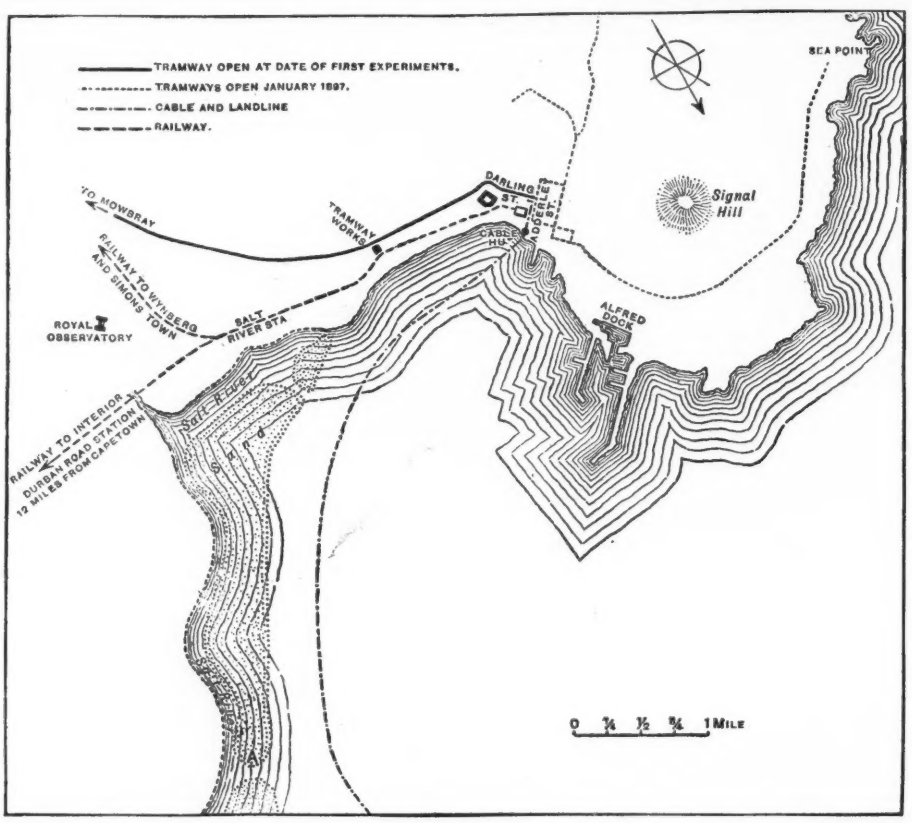


FIG. 1.

recorder. We waited until a car started, and simultaneously with the movement of the handle of the controller, a "kick" was recorded on the slip. In a report to the Postmaster-General, dated August 16th, 1896, I suggested that the disturbance might be due to the direct leakage of current, owing to the use of earth as a return by the tramway, or to induction owing to the proximity of the cable; and that the first might be removed by the use of an earth at a considerable distance, and the second by an equal and opposite induction. I proposed a series of systematic experiments.

I am informed that with the co-operation of the Post Office, a number of earths were tried. A telephone line to the top of Signal Hill, a telegraph wire run down to the sea at Sea Point, and terminating in an earth plate in the sea, an earth at Observatory (3¼ miles from Cape Town), an earth plate in the Alfred Docks, an earth at Durban Road (12 miles from Cape Town along the main line of the railway), an earth plate near the cable hut, an earth in the garden of the Standard Bank, and the rails of the tramway, were all tried alone, and in parallel with the sheath of the cable. No reduction of the disturbance was found, and, on the whole, the ordinary earth on the sheath gave the best results.

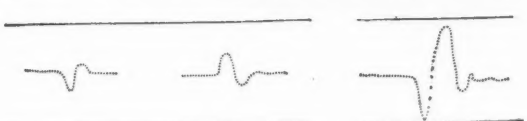
On August 26th I was invited to take part in the experiments by Mr. T. Cassidy, superintendent of the cable company at Cape Town. Before dealing with the experiments, I will briefly describe the nature of the disturbances.

The cable was sometimes connected to Mossamedes. I am informed that the length is 1,383·526 knots, and the resistance 8,820 ohms. It was sometimes put through to Loanda, 530 knots up the coast. It is worked with 35 cells, and a condenser of 60 microfarads. The resistance of the coil of the recorder is 500 ohms. In sending, it is shunted with 1 ohm. No disturbances are perceived during sending. In receiving, it is sometimes shunted with 6,000 ohms.

As this is a matter which concerns tramway engineers as much as cable men, and as the former have little opportunity of acquainting themselves with the work of the latter, it may be worth remarking that such a cable as this one is always worked through condensers, for the purpose of cutting off earth currents. A paper tape 16 mm. wide is drawn at about 10 mm. per second under a siphon which is kept in motion by an electric vibrator. It is worth noting, for examination of the details of the disturbances, that the vibrator in the present case gave about 32 dots per second.

The "kicks" are of three kinds. The first—the starting and stopping kicks—are shown in fig. 2. A starting kick for a car between the works and Cape Town resembles the signal for an N. The first swing is below the line, and falls to about 2·5 to 3 mm. in about 0·2 of a second. This delay is due to the inertia of the working parts of the instrument. This swing is followed by a swing above the line. This is simply a mechanical overshoot of the instrument. It is generally about three-fourths of the amplitude of the swing. A third and even fourth swing is sometimes seen. Such a kick is due to the switching on of about 20 amperes by putting a controller on a car to the first notch. A stopping kick is reversed, and resembles the signal for an A. Its amplitude depends on the current which happened to be passing at the moment of breaking.

A second kind of disturbance is shown in fig. 3, and may be called a "splash." The siphon is often thrown right off the paper, but the instrument has never been damaged. A disturbance of this kind is



FIGS. 2 AND 3.

comparatively rare. So far as I have observed, it always begins downwards. It is therefore probable that it is due to the sudden switching on of a considerable current. It is more or less sharp-pointed, and the rebound is sometimes greater than the first swing; both of these features are, I believe, mechanical.

The third kind of disturbance is a comparatively small and irregular quiver of the line, and is probably due to the jumping of the trolley at insulators and points, and perhaps to sand on the rails.

In order to form some idea of the magnitude of the disturbing currents in the cable, the siphon recorder was, at my request, discon-

nected entirely from the lines, condensers, and instruments. I then connected a Clark cell through 100,000 ohms and applied it direct to the instrument, under its ordinary conditions of shunt and control. Quickly snapping the contact gave a kick closely resembling a starting kick. The first swing was 2 mm. Holding down the contact, the line settled down, after one or two small oscillations, with a permanent displacement of 1-7th mm. (fig. 4).

As the various earths had failed to reduce the disturbances, and as there was no cable ship at Cape Town to lay an earth out to sea, I attempted to apply an equal and opposite induction. I arranged with the Post Office for the use of a private telephone line from Cape Town to Mowbray, running alongside the tramway for 2½ miles, and a distance of about 1¼ miles beyond the terminus. This line was almost useless to the subscriber, on account of the disturbances caused by the tramway. On August 27th this line was earthed at Mowbray, and was connected through the usual condenser of 60 microfarads with the siphon recorder at the cable office, and was earthed on the sheath of the cable. At the same time another recorder at the cable hut was connected, also through the usual condensers, to the core and sheath of the cable. The instruments were run simultaneously, and the time was marked at every 10 minutes on each slip, and these were afterwards compared. Every disturbance on the cable was clearly reproduced on the telephone line, with an amplitude about five times greater. Not a single kick on the cable failed to be represented also on the telephone line; but many of the smaller ones on the telephone line were not visible on the cable slip, on account of the small amplitude (fig. 5). A marked difference between the kicks produced by the telephone line and those produced by the cable is worth notice. It may be seen in fig. 5 that the telephone kicks are always sharp pointed; a simple kick never has any sign of a rounded top, and there is seldom any trace of a rebound. I had no opportunity of examining this more fully. It did not strike me until later that the absence of any overshoot may be due to the relations of the inductance, capacity, and resistance of the phone line, calculated from the gauge of the wire (No. 18 bronze), is 280 ohms, and I understand that the resistance of the whole circuit may be taken at about 800 ohms. I fail to understand how the conditions of the telephone line could produce any appreciable prolongation of the discharge; but it is possible that the overshoot of the kicks on the cable may be due to the fact that the resistance of that part of the cable which is being affected is small, and that the length affected is short. There is no material difference between the recorders.

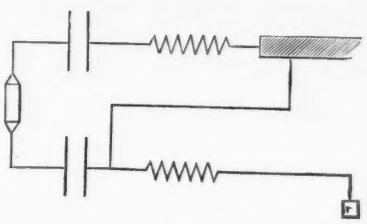
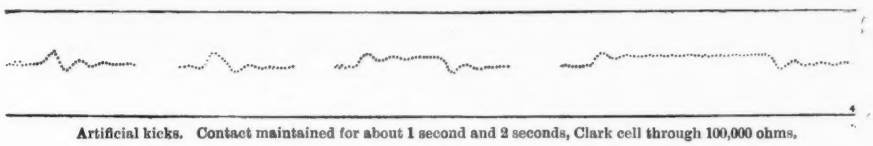


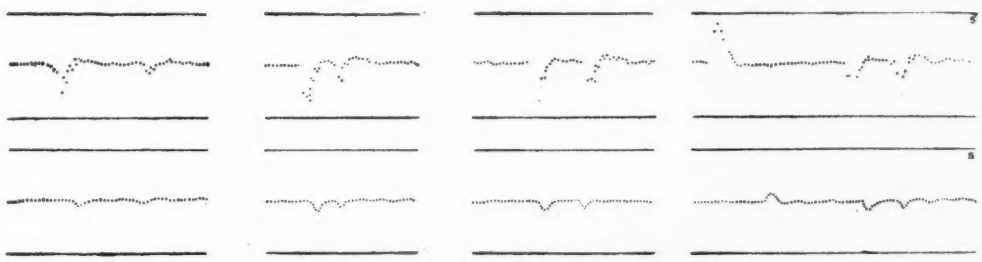
Fig. 8.

The next day—August 28th—was wet, but no difference was observed in the disturbances. An attempt was made to earth the cable through the telephone line, but, owing to some mistake about the connections of the condenser, the zero wandered. On August 29th the experiment was repeated, the connections being made as in fig. 6.



Artificial kicks. Contact maintained for about 1 second and 2 seconds, Clark cell through 100,000 ohms.

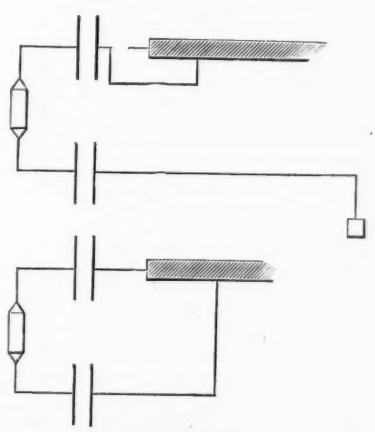
Fig. 4.



Upper slip, telephone wire. Lower slip (travelling rather slowly) cable.

Fig. 5.

line. At first I thought that the rounded top of the ordinary kick (fig. 2) was due to the capacity of the cable; but fig. 4, in which no condenser was employed, shows that this is not the case. The



Figs. 6 and 7.

discharge was evidently instantaneous; but the fact that the line does not drop to zero until 0·2 to 0·3 second does not indicate that the current died away at the same rate. If the current died away twice as fast, or even three times as fast, it would probably check the swing in this manner. The metallic resistance of the tele-

The siphon recorder, protected on each side by condensers of 60 microfarads, was connected to the sheath of the cable and to the telephone line, this line being earthed at the far end. The telephone line gave kicks as on the previous occasion. The instrument was then connected to the core of the cable through a condenser in the usual way, and earthed to the sheath. The cable was through to Mossamedes, and the usual kicks were observed. Fig. 7 shows the connections.

An auxiliary and disturbed (?) earth was then connected by putting the telephone wire to the sheath through a resistance. A rheostat was also placed in circuit with the cable, and these resistances were varied (fig. 8). In order that the kicks might be comparable, signals were made from the window of the cable office to the driver of any car that happened to be standing at the terminus. The kicks were not materially reduced in amplitude until 100,000 ohms were introduced into the telephone line, or 8,000 into the cable circuit; the latter being, of course, an impracticable condition for working.

In order to study more closely the nature of the disturbances, the tramway companies arranged for a night test, and the programme which was suggested in my report to the Postmaster-General of August 16th was carried out. On August 31st, at 11.45 p.m., the cable being put through to receive from Loanda, and the tramway service being stopped for the night, a tramcar started from the works to Mowbray. According to a previous arrangement it stopped at Woodstock at 11.55, at Great Moore Street at midnight, and arrived at Mowbray Hill at 12.10. It then returned, and stopped at Salt River at 12.30, and Castle Bridge at 12.40, arriving at the end of Darling Street a few minutes later. The time was marked on the slip at every 10 minutes, and the stoppings and startings were clearly recognisable. Two points were clear—first, that the amplitude of the kicks was in proportion to the distance of the car from the works, but rather greater on the Cape Town side; and, second, that the direction was reversed when the car passed the works.

An important experiment, suggested by Mr. W. B. Rommel, was carried out after this run. A feeder buried in the street was connected to the negative pole of the dynamo at the works, and a

branch from this feeder was brought into the cable office. A rheostat was connected, and currents varying from 40 to 100 amperes (at 500 volts) were sent through the completely insulated circuit formed by the feeder and the trolley wire. No kicks whatever were visible, and the line remained perfectly straight. The cable was through to receive from Loanda with the usual connections.

A line was then run out to the rails in the street, and currents were sent by means of the rheostat. They produced violent kicks, a current of 40 amperes sending the siphon off the slip.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

10,295. "An electrical advertising balloon." J. Bussby. Dated April 26th.

10,320. "Improvements in the manufacture and production of bodies for use as filaments in electric incandescent lamps or for making hoods or mantles for incandescent gas lighting or for like purposes." M. Sheftel. Dated April 26th.

10,411. "A patent 'ball light' fitting for use in connection with incandescent and other electric lamps." R. S. Keep & Co. Dated April 27th.

10,429. "Improvements in underground conduits or trenches for electric railways and the like." J. D. Griffin and G. S. Small. Dated April 27th. (*Complete.*)

10,439. "Improvements in secondary batteries." C. E. Lee. Dated April 27th. (*Complete.*)

10,444. "Improvements in portable electric batteries." R. R. Moffat. Dated April 27th.

10,451. "Improvements in separating stable salts by means of diffusion and generating electricity direct out of chemical energy." F. S. Brown and L. J. Davies. Dated April 27th.

10,458. "Patent electric light glass abat-jour." A. Gaetz. Dated April 27th.

10,494. "Improvements in electric gas lighters." L. L. Borrodaile. Dated April 27th. (*Complete.*)

10,505. "Improvements in electric arc lamps." H. V. James. Dated April 27th.

10,521. "Improvements in means and arrangements for exhausting incandescent electric lamps, vacuum tubes, and similar articles." C. M. Johnson. Dated April 27th.

10,530. "Improvements in electrical conductors." G. Gray. Dated April 27th.

10,582. "Improvements in brushes for dynamos and electric motors." F. Guy. Dated April 27th.

10,610. "Improvements in or relating to electric stations and apparatus employed therein." A. J. Boult. (X. M. Roux, Belgium.) Dated April 28th.

10,629. "Improvements in or relating to prepayment electricity meters." C. O. Bastian and F. M. Staunton. Dated April 28th.

10,654. "Improvements in electric fittings." E. J. Pipes. Dated April 29th.

10,680. "An improved holder for contact brushes, carbons, or other devices used in electrical apparatuses." W. J. Poole. Dated April 29th.

10,705. "An improvement in plates for secondary voltaic batteries." L. Epstein. Dated April 29th.

10,708. "Improvements in and connected with magnetic compasses." E. A. Reeves. Dated April 29th.

10,719. "Improvements in primary batteries." W. Rowbotham. Dated April 30th.

10,732. "Improved portable electric lamp for use in explosive atmosphere." A. C. Wilson and W. H. Roberts. Dated April 30th.

10,737. "Improvements in electric arc lamps." A. W. Richardson. Dated April 30th.

10,755. "Improvements in or applicable to electrically driven cranes." W. Craven. Dated April 30th. (*Complete.*)

10,757. "Multiple electric switch controlling one or more circuit." A. Wiechmann and H. Wiechmann. Dated April 30th.

10,758. "Improvements in means for connecting electric conductors to lamps, switches, or other electrical fittings." T. H. Marsh and A. Vandham. Dated April 30th.

10,772. "Improvements in the generation of steam by means of electricity." J. H. Dunn. Dated April 30th.

10,778. "Improvements in electrical time indicators." S. P. Trasher. Dated April 30th.

10,792. "Improvements in apparatus for distributing electricity." H. Pengelly. Dated April 30th.

10,822. "Certain improvements in apparatus for the electro-deposition of metals." W. Evans and J. W. Smith. Dated April 30th.

10,830. "An electric alarm for oil pumps." W. Fletcher. Dated May 1st.

10,859. "Improved combined walking stick and medical coil." W. N. Sherman and C. B. Harrell. Dated May 1st.

10,864. "Improvements in electric rail contacts or treadles for railway signalling, and other purposes." F. T. Hollins. Dated May 1st.

10,872. "Improvements in or relating to electric batteries." J. Sime. (R. Jamieson Brown and J. G. Dobbie, India.) Dated May 1st.

10,908. "Improvements relating to the transmission of signals through submarine telegraph cables." F. L. Muirhead. Dated May 1st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1897.

483. "Improvements in electric arc lamps." A. G. Stockwell. Dated January 7th, 1897. Relates to improvements in the brake mechanism of electric arc lamps, one of which consists in constructing the brake band of a number of oblong plates and curved distance pieces for clutching the wheels, also a spring attachment having tension applied by springs. 3 claims.

2,082. "Improvements in and relating to electric furnaces." J. Joyce and J. A. Deuther. Dated January 26th, 1897. Relates to improvements in electric furnaces for the manufacture of calcium carbide, and for the reduction of refractory or other metallic compounds. The main object being to facilitate the bringing of the material to be treated directly within the influence of the electric arc formed between two separate electrodes and through which the current passes. Mechanism is provided for varying the distance between the electrodes and also for moving the lower electrodes from its normal position to expose the same to receive the material to be treated, and a feed mechanism connected to said upper electrode and adapted to be operated by the movement of the said lower electrode to intermittently feed the material to be treated on to the lower electrode. 4 claims.

2,592. "Improved electric fuse for mines." R. Linke. Dated February 1st, 1897. Relates to an electric fuse composed of a platinum and copper wire bound together and wrapped about with long fibrous highly nitrated cotton wool, the covering being thereafter soaked in a solution of collodion in order to obtain a highly sensitive fuse, capable of unlimited handling and protected against outside pressure and shocks. 1 claim.

4,051. "Improvements in underground conduits for electric wires." H. H. Lake. (E. S. Perot.) Dated February 15th, 1897. Relates to a sectional underground conduit for containing electric wires, which shall be watertight when laid and the successive lengths of which shall be provided with means for easy and stable articulation. Each section consists of a shell, a cement lining therefor, and end rings which form the opposite members of a wedge joint. 3 claims.

4,427. "Improvements in and connected with telephones for domestic use." G. L. Anders, J. E. W. Wedekind, and T. Miller. Dated February 18th, 1897. The object of the invention is to provide a small concentric telephone of the direct working type, suitable for use as a substitute for the ordinary electric push button so as to admit of telephonic communication between various points in an ordinary electric bell system as used in hotels, private houses, &c., and at the same time to more nearly resemble in appearance and size the ordinary push buttons and to be capable of similar decorations. 6 claims.

6,155. "Electrical road traction installations worked by means of both alternating and continuous currents." Max Debi. Dated March 9th, 1897. Relates to improvements in electrical road traction installations, the simultaneous employment of single or polyphase alternate current motors and continuous current motors, both descriptions of motors being mounted on one and the same axis, or on different axes of the same vehicle or the same tram, and the alternate current motors being supplied with alternating currents by the line conductors from stationary current generators, while the continuous current motors are so connected to accumulator batteries on the vehicle that they are thereby at one time charged by means of the excess of propelling energy, while at another time they give out such stored energy in assisting in propelling the tram or in effecting the starting and propulsion of the tram. 1 claim.